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INSTRUCTIONS TO FIELD REPRESENTATIVES
RELATING TO PREPARATION
OF
SYSTEM LOAD STUDIES

(11-15-47)

APPLICATIONS AND LOANS DIVISION
RURAL ELECTRIFICATION ADMINISTRATION
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D. C.

MEMORANDUM

January 7, 1948

To: All Field Representatives
Applications and Loans Division

From: Arthur W. Gerth, Chief
Applications and Loans Division

Subject: System Load Study Manual of Instructions

The attached System Load Study Manual outlines methods and procedures for use by field personnel in preparing studies of the present and future power requirements of REA borrowers' systems.

In contrast to Field Appraisals, as conducted by the Economic Staff of the Applications and Loans Division, System Load Studies do not purport to establish the economic feasibility of borrowers serving all potential loads included in a given load study. Whereas the KWH estimates and other basic data as derived from Field Appraisals form the basis for studies of the economic feasibility of specific loan applications, the KWH estimates obtained in System Load Studies are incidental to the primary purpose of load studies -- that of determining approximate kilowatt demands, load centers for power deliveries, and other information necessary for future planning and a determination of design characteristics.

The conduct of System Load Studies and Field Appraisals by REA field personnel is limited by established procedures to those systems which have a definite need for the respective type of survey. Such studies will be coordinated within the Division to avoid any duplication of effort on the part of personnel assigned to these two activities. For this reason, a System Load Study shall not be undertaken by a field representative without prior authorization from the Office of the Chief of the Applications and Loans Division.

Arthur W Gerth

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INTRODUCTION

A System Load Study is a study of a specified area for the purpose of determining types of loads and their distribution in the area, estimates of KWH consumption, power requirements and approximate load centers for power deliveries. Purposes to be served by a system load study are as follows:

(a) To permit the making of engineering and economic studies relating to the construction or extension of transmission networks of public power agencies and generating and transmission systems to assure adequate low-cost wholesale power.

(b) To permit adequate engineering studies of the modification of present borrowers' facilities and the design of future construction.

(c) To provide a foundation for a sound long-range rate structure.

(d) To serve as a guide for an effective power use program.

The need for System Load Studies is particularly urgent at this time in parts of the country where power facilities of public power agencies are being planned and constructed to serve areas in which REA-financed systems are located. Similar need exists for determining the power requirements of borrowers being served by REA-financed generating and transmission facilities in order to properly coordinate design characteristics with future expansion and growth in loads, and to assure adequate supplies of low-cost power.

Since electric cooperatives (and public bodies) have preference over other potential purchasers of power generated in connection with multiple purpose dams developed and constructed by the U. S. Army Engineers, it is incumbent upon the Rural Electrification Administration and REA-financed borrowers to cooperate with the government agencies having responsibility for disposing of such power and to provide estimates of the power requirements of the borrowers located in the areas to be served by these developments. This is necessary to safeguard the right of borrowers to purchase such power as well as to aid in the planning and justification of facilities incident to the marketing of power developed at these dams.

In the past year the Rural Electrification Administration has been called upon by the Bonneville Power Administration and the Bureau of Reclamation, as well as by the Division of Power of the Department of Interior and other agencies, to provide comprehensive studies of the potential power requirements of REA-financed borrowers situated in the areas to be served by power facilities of these agencies. To date, approximately twenty such studies have been undertaken, fifteen of which have been released, and out of which has come, in part, the present procedure for making system load studies.

In recognition of the need for system load studies, the Administrator in a memorandum dated November 22, 1946, addressed to Division Chiefs, established administrative procedures under which system load studies will be prepared. Excerpts from the Administrator's memorandum are quoted below:

> "System load studies shall be made by the Applications and Loans Division .....
>
> "The Office of the Chief of the Applications and Loans Division shall establish uniform policies and plans for system load studies and shall maintain appropriate controls over the assignment and progress of such studies......
>
> "The Applications and Loans regional field representative shall supervise the making of the field survey.....
>
> "A detailed system load study manual of instructions shall be prepared for use of the field representatives.....
>
> "The Office of the Chief of Applications and Loans Division shall assign field representatives to make system load studies. The field representative shall follow in detail the manual of instructions for making such appraisals".

Part II of the Administrator's memorandum of November 22, 1946, pertaining to the preparation of system load studies is reproduced in its entirety as Appendix E.

This manual is an integral part of the administrative procedure referred to above and provides a basic guide for use in the preparation of System Load Studies in the field. It outlines in systematic manner the factors which should be given consideration in making all system load studies in order that uniform studies will result. The field representative is encouraged to report his experience in the use of this manual and to submit suggestions and comments for improving the methods and procedures as outlined herein.

INSTRUCTIONS TO FIELD REPRESENTATIVES RELATING TO

PREPARATION OF SYSTEM LOAD STUDIES

Procedures and Methods for Making System Load Studies in a Specified Area for the Purpose of Determining the Types of Loads and Their Distribution in the Area, Estimates of KWH Consumption, Power Requirements and Approximate Load Centers for Power Deliveries.

I. GENERAL INSTRUCTIONS.

This manual sets forth methods and procedures to guide field representatives in making a practical determination of the prospects for electrical power consumption within a given area based on an evaluation of the basic data concerning the area itself. The methods and procedures as outlined are to serve as a guide to field representatives in making such determinations and to insure uniform treatment in the preparation of a System Load Study Report.

A. REA-Financed Systems on which System Load Studies Will be Made:

Due to the limited number of field personnel available for this activity and the time required to make such studies, System Load Studies will not be made for all REA-financed systems but will be confined to systems where there is an immediate need for them. Generally speaking, the need will be greatest among systems of existing borrowers with lines in operation. Conditions under which system load studies would be made include:

1. Systems located in areas served or proposed to be served by public power facilities where it is necessary to provide load estimates as a basis for planning and justifying the extension of power facilities by such agencies to serve REA borrowers and other loads.

2. Systems served or to be served from existing REA-financed generating and transmission facilities.

3. Systems which because of unusual circumstances should have system load studies made as determined by the Administrator or the Chief of the Applications and Loans Division.

In case a system load study is to be made in an area where no REA-financed system now exists and where the prospects are good that a project may be developed, a field appraisal covering the entire area included in the optimum boundaries of the system will be conducted by the Economic Staff of REA. The procedures as outlined herein will not apply in such cases.

B. Designation of Field Personnel to Make System Load Studies

Personnel for making system load studies will be assigned by the Office of the Chief of the Applications and Loans Division, from present Applications and Loans Division field forces working in the respective regions in which load studies are to be undertaken.

C. Training of Personnel Designated to Make System Load Studies

Each field representative selected to make system load studies will be given an intensive course of instruction in the use of this manual by the System Load Study Specialist and the Economic Staff at headquarters. After such training period, the field representative will be accompanied on his first assignment by a representative of the Applications and Loans Division who has had previous experience in Load Study work. This latter training period will consist of the time required to make one complete load study report. After the initial study, the field representative will be expected to complete other similar studies without assistance.

II. COLLECTION AND ASSEMBLY OF BASIC DATA RELATING TO LOAD ESTIMATES

The field representative will find it necessary to collect and assemble a variety of information and data pertinent to the area as well as to the system under study. Since the area coverage plans and optimum boundaries of a system usually comprise all of a county or significant parts of several counties, it will be necessary to report some of the data called for in this Section by counties. Other of the information which may equally apply to all of the area under study may be reported as applicable to the entire system. Any variation of factors related only to particular areas of the system should be described fully and these areas delineated on the unelectrified farm survey maps.

It is urged that all available sources of information in a given area be utilized to the fullest extent by field representatives in collecting the information required in this Section. The authorities to be contacted by the field representative may include but are not limited to the following officials of agencies serving the area in which the load study is to be made: County extension agent and home demonstration agent; farm supervisor and home management supervisor of the Farmers Home Administration; secretary of the National Farm Loan Association; secretary of the Production Credit Association; County Agricultural Conservation Association Committee; persons in charge of field offices of the Soil Conservation Service, Forest Service, Geological Survey, Bureau of Reclamation or other federal, state or county agencies; directors and managers of REA-financed systems; county tax assessors and tax collectors; State and County Water Boards; appliance dealers; and sales representative of industrial and farm equipment.

It is emphasized that this outline may not cover all of the factors the field representative may expect to investigate. No practical outline can be prepared in advance of the load study which will anticipate all local factors, and current conditions in an area. The field representative should, therefore, be alert to obtain complete, detailed information on any matters which may affect the future load of a system. Comparison of the present condition or situation with that of previous years and that to be expected in coming years is desirable.

A. Determination of the Number of Each Class of Consumer to be Served by the System.

In order to estimate future power requirements of a system, it is first necessary to determine the number of each class of consumer which will be served by the system at the end of two years, five years, and ten years. (As of to date, these periods will correspond to the years 1949, 1952 and 1957, respectively). Determination of the power requirements at the end of two, five and ten year periods is necessary in order that they may be of maximum benefit in the planning of facilities. Requests for load data by public power agencies, as well as by the Generation and Transmission Section of REA, require such a breakdown of loads by periods.

This determination of the number of each class of consumer which will be served by the system in two, five and ten years (1949, 1952 and 1957) must be made for each section of the system which is or will be served from a separate point of delivery of wholesale power. The most common types and classes of consumers which may be served by REA-financed systems are shown below together with suggestions as to the manner of determining the number in each class.

1. Farm Consumers:

One of the first steps to be undertaken in preparing a system load study is to complete the Inventory of Unelectrified Farms, (or survey of unelectrified farms). It is desirable that the Inventory of Unelectrified Farms be completed prior to the time the field representative making the load study reaches the project. However, if the survey has not been completed, it will be necessary that the borrower start it at once. This work should be done by cooperative personnel (or by community volunteers where no borrower exists) with a limited amount of supervision by the fieldman making the load survey. The procedure to be followed in conducting the Inventory of Unelectrified Farms is outlined in Appendix A.

Results of the unelectrified farm survey will provide the basis for estimates of the number of farm consumers to be served by the system. Since the load study is to provide estimates of loads for two, five and ten year periods hence, it will be necessary for the fieldman to estimate the number of farm consumers to be served by the system at the end of the two, five and ten year periods (1949, 1952 and 1957). The number of farm consumers to be served by the system at the end of the year 1949 may be taken as the number presently served plus those that will be served by construction which will be completed during the period 1947-1949.

In most cases these counts should be of existing consumers presently served by the system plus existing potential consumers which may be served. Exception to this rule should be taken if there is convincing evidence that the number of farms will materially decline or increase during the next ten years. Such modification may be made in other consumer classifications (discussed below) if there is sufficient basis to warrant it. During the early years of the estimates, the plans of the borrower for extending its system should be taken into consideration in determining the number of consumers to be served in each period of the estimates. It should be assumed that the ultimate number of consumers will be served by the end of the tenth year (1957).

It is emphasized that the determination of the number of consumers to be served refers to consumers which will be served

by the REA-financed system under study. Allowance should be made in determining such estimates for farm consumers which may in the future be served by utilities or power companies, and for consumers which for various reasons may not be expected to be served by the system under its area coverage plans. The basis for the number of farms to be served in each period of the estimates shall be clearly stated.

2. Non-Farm and Small Commercial Consumers:

Non-farm and small commercial consumers should be treated in much the same manner as farm consumers. The unelectrified farm survey should be conducted in such a way that the number of each of the non-farm and commercial consumers (with such modification as may be indicated) can be determined and estimates made of the number of each type that will be served at the end of the two, five and ten year periods.

a. What is the future condition likely to be relating to non-farm residence?

b. What are the possibilities of increasing or decreasing the number of non-farm residences?

c. What are the kinds of business of commercial consumers?

Consider such factors as continuity and stability of enterprises supporting the community or area.

3. Seasonal Cottages and Recreational Consumers:

On a great many systems the load imposed by seasonal cottages and recreational consumers is significant. The unelectrified farm survey and system records will disclose the number of such establishments within the system boundaries at the time of the survey; however, the possibilities for further development and the construction of additional seasonal and recreational facilities should not be overlooked. Estimates of the number of future consumers of this type should be based on the trend in the use and development of recreational facilities in the area.

a. Is the existing or proposed system development in or near a resort or recreational area?

b. To what extent will the resort or recreational area use electricity?

c. What percent of the seasonal cottages are "summer cottages" as distinguished from "week-end cottages"?

4. Rural Industries (Power Loads):

There are a multitude of different types of power loads which may be served by REA-financed systems. A few of the possible types of rural industrial applications in manufacturing would be:

- Chemicals
- Forest Products
- Mineral Products
- Processing and Preservation of Agricultural Products
- Stone, Clay and Glass Industries
- Textile Industries
- Construction Industries
- Manufacturing Industries

Some examples of specialized agricultural applications which would require consideration comparable with that for the above industrial applications would include:

- Truck Farms
- Alfalfa Processing
- Rice Drying Plants
- Cotton Gins and Compresses
- Seed Processing
- Turkey Ranches and Poultry Farms
- Slaughter House
- Locker Plants and Coolers
- Hatcheries

A more complete list of the possible rural industrial applications of power which may be served by REA-financed systems will be found in Appendix F.

The type of plants to be found in a given area will in large measure depend on the natural resources and the kind and variety of raw products produced. A determination of the number of such plants or power loads which may be served by the system will require a complete investigation by the fieldman and personal contact with existing and potential operators of such establishments. Personal contact will be required in all cases to determine the magnitude of power loads and to ascertain estimates of power consumption and other necessary information. Future potential power loads should be included if there is reasonable assurance and justification that such loads will develop and be served by the REA borrower. The number of power consumers of the various types should be determined and listed for each of the two, five and ten year periods.

a. What are the possible rural industrial applications, both present and future?

b. Are these industries now operating in the area, or is their future operation dependent on central station electric service?

c. What are the present sources of power of these industries and will they use power from the proposed system?

5. Irrigation Consumers:

The number of irrigation pumps requiring power for pumping should be determined carefully since such loads have an important bearing on the design of the system. All possible sources of information including state and county water boards, state regulatory bodies, U. S. Geological Survey, Soil Conservation Service, Farmers Home Administration, county agents and others should be contacted in determining irrigable areas, availability of water, amount of water required for crops, etc. Wherever possible, supporting information in the form of published or confidential official reports and other material obtained from federal, state or county officials should be included to substantiate the feasibility of irrigation in the area. Estimates of the number of irrigation pumps should be made for the periods of two, five and ten years hence. Locations and sizes of existing pumps and wells should be shown on the unelectrified farm survey maps.

a. Is irrigation practised in the area?

b. If so, how is it accomplished and what crops are produced?

c. The number of wells pumped?

d. The crops irrigated and the acreages of each?

e. The acre feet of water pumped per season?

f. The length of the pumping season?

g. The depth of the pumping level?

h. The draw down?

i. Size of well casings?

j. The size and types of present prime movers?

k. The size and type of pumps? How are they connected to prime movers? (Direct or belt connected?)

l. In the case of pump irrigation, what is happening to the water table? Discuss and give source material.

m. Is there possibility of increasing the irrigated acreages?

n. What are the problems connected with irrigation in the area?

In the event that irrigation is not practiced in the area and is under consideration at this time,

o. What would be the source of water?

p. Is the source adequate and is the water suitable?

6. House Heating Consumers:

Numerous types of electric house heaters have been designed and tested in the past few years. At present both central forced air furnaces (without heat storage) and unit type individual room heaters are the only type of electric heating equipment that has operated in sufficient quantity and for a long enough time to establish conclusive operation costs. Generally speaking, electric heating is practical when power costs do not exceed one cent per kilowatt-hour.

Many experiments are going on today with radiant panels, central forced air plants of various types, both with and without heat storage features, and heat pumps (reverse refrigeration cycle units). It is not unlikely that within the next ten years considerable advancement in the practice of electric house heating will be seen.

Estimates of the number of consumers using electricity for house heating are difficult because of the lack of basic data. In certain areas of the Northwest where the heating of homes with electricity (space heating) is rapidly gaining favor, estimates of 1 percent of the farm and village dwellings to be electrically heated within two years, 2.5 percent within five years, and 5 percent within ten years have been made. However, these estimates may not be applicable to other areas. Such a determination would best be arrived at by the fieldman after a careful study of local conditions and a finding of whether the idea of electric house heating is prevalent in the area; whether any installations are in existence at the present time and how many; and whether the REA borrower has received any inquiries from its members regarding electric house heating.

7. Acquisition:

Possible acquisitions represent substantial potential additions to the load requirements of many REA borrowers' systems. Loads of this type should be included in the system load study if there is reasonable justification and assurance that existing electrical properties may be acquired and served by the borrower. In instances where the acquisition of existing facilities is included in the load survey, enough general information should be obtained to enable the fieldman to estimate the acquisition

load for the period or periods during which it will be served. For purposes of a load study it is not necessary to obtain a breakdown of the number and classes of consumers comprising a proposed acquisition. The property to be acquired may be considered as one aggregate load without regard to the number of consumers to be served. However, in cases where an acquisition has been completed, or is pending, a detail breakdown of the number of each class of consumer should be obtained for each town as well as for the rural areas served by the acquisition property.

8. Other Consumers:

The classes and types of consumers listed above will in most cases cover the various types of consumers which may be served by an REA-financed system. There may be instances, however, of other types of consumers served or to be served, such as wholesale service by the system to a municipality or power company, or other type of consumer. In these cases, the number and type of such loads should be listed separately for each of the two, five and ten year periods.

B. Physical Characteristics of the Area.

1. What is the location of the area? List the counties included and briefly describe the boundaries of the area under study.

2. Describe the topography and cover of the area.

3. a. Describe the soils and subsoils of the area, including the texture, structure, fertility, moisture retaining characteristics, productive capacities, etc.

   b. Is the land subject to wind or water erosion?

   c. If so, what is the extent of the erosion, and what is being done to check it?

4. a. Describe the climate?

   b. What is the average annual rainfall, and when does it occur?

In some areas climatic factors condition every other consideration in farming and drastically reduce the alternatives of the farmer in planning his farming operations.

C. Types of Farming:

Types of farms and enterprises have a direct bearing on the basic KWH farm consumption requirements of an area as well as on income with which the farmer may buy electrical appliances and equipment. Principles of farm management and the basic things which go together

to identify types of farming areas and farm enterprises have been well established. Field representatives will find them a useful guide in understanding and evaluating farm electrification as to the proper sphere of influence on farming.

1. a. What are the present major types of farming enterprises in the order of their importance? What percent of the farms fall in each type?

   b. What crop specialities, such as sweet corn for canning, sugar beets, peanuts, melons, fruits, etc., are grown and what is the importance of each? Markets, soils, climate and other important factors considered, what are the possibilities of further developing these specialities or of adding others.

The 1945 Census of Agriculture provides data on types of farms by counties, based on the 1944 gross farm income sources; these data may be used as a guide in discussing present types of farming with the authorities interviewed. In scheduling load study assignments, the Office of the Chief of the Applications and Loans Division will furnish the field representative census data in advance of his arrival in the area to be surveyed in order that this information will be available to him in discussions with county agents and other authorities in the area.

D. Size of Farms, Settlement

1. a. Has the size of farms and number of farms undergone any appreciable change in recent years?

   b. What caused the changes?

   c. Are the changes permanent?

2. a. Has there been or is there likely to be any substantial change in the total acreage of farmland?

If a substantial change may occur because of the retirement to forest, because of zoning, because a large dam will cause the low land to be inundated, or because of other similar reasons, the field representative must estimate the farmland acreage and the number of farms that will be eliminated, and determine whether farms included in the area to be served by the system will be among those eliminated.

E. Farm Income

Income is an important factor which has to be taken into account when considering kwh consumption per consumer, although other factors often are of greater importance. Very low income may be a barrier to the connecting of many prospective consumers because of inability to pay for wiring, and it may restrict consumer usage

because of lack of funds to buy major appliances. However, once income reaches a reasonable level, the relative cost of electric energy and competitive sources of energy, as well as promotional effort, appear to be principal factors which influence average consumer usage.

1. a. From the 1945 Census of Agriculture, list in table form, by counties, a breakdown of the value of all farm products sold (list by principal categories such as All Crops Sold, Dairy Products, Poultry and Poultry Products, etc.), together with the value of farm products used by farm household.

   b. What is the average value per farm of all farm products sold or used by farm household?

2. a. What percent of the farms, by counties, fall within the respective income groups (0- $250, $250 - $399, etc.) as reported by the 1945 Census of Agriculture?

   b. What percent of the farms fall within these income groups for all counties of the system area combined? (Show in table form).

3. a. What percent of the total food supply for an average family in the area is produced on the farm?

   b. What would be the dollar value of the part of the food supply produced on the farm?

4. a. To what extent are there possibilities of working off the farm?

   b. What is the annual income per family from such work?

F. Natural Resources

The presence of some of the more important types of rural industries which may be served by a system is in large measure determined by the existence of natural resources in the area. Sawmills, shingle mills, mines, quarries, oil wells, etc., are examples.

1. a. Does the area have timber, mineral or petroleum deposits, or other natural resources of like nature?

   b. To what extent are they developed?

   c. What is the importance of the resource to the welfare of the community?

G. Marketing Facilities and Outlets

1. a. What marketing outlets (existing city markets within reasonable shipping distance or existing commercial storage or

processing plants buying farm products outright, such as grain elevators, canneries, milk condenseries, milk drying plants, egg drying plants, feed mills, etc.) are available for the farm products?

b. Discuss the road system and rail service.

c. Is the area served or likely to be served by air transportation?

H. Other Factors

1. a. What will be the effect of such possible influencing factors as low cost hydro power, use of home plants, competition of gas, income and savings of consumers, stability of population, progressiveness of the community, etc., on the rate of increase in KWH consumption and the maximum average to be attained in ten years?

b. What is the general attitude of the people towards programs conducted by the Agricultural Extension Service and Vocational Agriculture Instructors, Home Demonstration Agents, etc.?

c. What interest has been manifest in farm organizations, 4-H Clubs or similar organizations?

d. What facilities are available locally for conducting a power use and cooperative education program? (This would include borrower's facilities, such as rural electrification advisor, as well as facilities of the Extension Services and Vocational Schools).

III. DETERMINATION OF AVERAGE KWH CONSUMPTION AND KW UNIT DEMAND VALUES FOR EACH CLASS OF CONSUMER, OR INDIVIDUAL CONSUMER.

Having determined the number of consumers in each classification for each period of the estimates (two, five and ten years hence) together with other basic data concerning the area itself, the next step will be to determine estimates of average KWH consumption and unit KW demand values for each class or type of consumer during corresponding periods. Methods of determining average KWH consumption will vary between classes of consumers so that it will be necessary to consider each class separately and to analyze a number of factors affecting the use of electricity in each consumer class. In other cases, rural industries and power loads particularly, it will be necessary to treat individual consumer loads separately in arriving at the estimated KWH consumption and KW demands.

The total energy requirements (KWH) of a system at the end of two, five and ten years will be the summation of energy requirements of all classes or groups of consumers (plus system losses) for those periods. However, the total system demand (maximum KW demand of the system) may not necessarily be the summation of the maximum demands of all classes or groups of consumers since there will likely be some diversity in the time of occurrence of peak loads between individual consumers in the same class and between various classes or types of consumers. For this reason it may be necessary to apply suitable diversity factors 1/ to the maximum demands of consumers in the same class, and to maximum demands of consumers in different classes, in arriving at the demand that each consumer or group of consumers adds to the estimated system peak demand.

No simple formula or rule can be devised which might afford an easy method of estimating KWH consumption. Such information as can be given in this respect is intended only as guidance to the fieldman in formulating a judgment of the important factors affecting the extent of the future use of electricity for various applications in an area.

A. 1. KWH Consumption for Farm, Non-Farm, (Residential) and Small Commercial Consumers.

Various methods of estimating the average KWH consumption among farm, non-farm and small commercial consumers have been proposed, including the mail questionnaire and random sampling by means of personal interviews of a representative group of the system's existing and potential consumers. Due to the time involved and other limiting factors, the use of the mail questionnaire or the random sampling method is not recommended for system load studies. Rather, it is felt that a competent judgment and evaluation of factors obtained from local agricultural leaders and from an examination of the basic and historical data relating to the area itself will produce results sufficiently accurate for load estimating determinations.

1/ See Discussion on "Basic Concepts of Loads" Attached as Appendix B.

a. Analysis of Operating Records as an Aid in Determination of Average KWH Consumption for the Initial or Two-Year Period.

On existing systems with have been energized for several years, the importance of analyzing past operating data for indications in the rate of increase of the average KWH consumption cannot be stressed too highly. Certainly one major factor in determining the estimate of KWH consumption for the initial two-year period would be the consideration of the present KWH consumption per consumer. The age of the system is another factor which should be considered. The fieldman may elect to analyze the increase in KWH consumption of all or a representative sample of the system's initial or "A" Section consumers in order to determine what the average consumption may have been at present if the effect of "diluting" old consumers with new consumers had not occurred. Since it is likely that there has been an accelerated rate of increase in average KWH consumption per consumer on existing systems in the past 18 to 24 months, due to more and more appliances becoming available since August 1945, and since this accelerated rate of increase may likely continue for one or more years until the backlog in the availability of appliances has been overcome, it is recommended that operating records of the system be analyzed month by month covering a period of at least two or more years preceding the date of the survey. Results of this latter analysis should reveal the extent and consistency of recent increases in KWH consumption and should be considered as a factor in estimating the average KWH consumption on farms for the initial two-year period. The rate at which new consumers will be added on new lines to be constructed will also affect the fieldman's estimate of average KWH consumption in each period of the estimates.

b. Past Agricultural Production as an Indication of the Degree to which Electricity May be Used in Future Periods.

Yearly farm production as experienced in previous years may be divided into component parts in such a manner that the degree to which electricity can be advantageously applied in any area becomes more evident. This data is available from census reports and, as indicated previously, will be furnished the field representative by the Office of the Chief of the Applications and Loans Division. When properly evaluated, this information can provide the basis for more adequate power utilization estimates on farms.

Table I indicates the type of basic agricultural production data which will be assembled for each county to be served by the system and forwarded to the field representative making the load survey.

TABLE I

1 - Population of area - Rural and Urban
2 - Number of farms in the county
3 - Average size in acres
4 - Lands and Buildings Valuation - Average Per Farm
5 - Value of Implements and Machinery
6 - Small grains - percent of farms reporting acreage, and bushels:
    (a) Corn   (b) Wheat   (c) Oats
    (b) Sorghum   (e) Barley   (f) Rye
7 - Hay - Percent of farms reporting:
    (a) Alfalfa - Acreage - Tonnage
    (b) Tame Hay " "
    (c) Wild Hay " "
    (d) Sorghum Hay " "
    (e) All Hays " "
8 - Silage
    (a) Percent farms reporting
    (b) Acres per farm
    (c) Tons per farm
9 - Livestock - Percent farms reporting
    (a) Cows - Number and Purpose
        (1) Dairy
        (2) Beef
        (3) All cattle (over 3 months)
    (b) Hogs (over 4 months)
    (c) Sheep (over 6 months)
10 - Poultry - Percent farms reporting
    (a) Chickens - Number and Purpose
        (1) Laying Hens
        (2) Broilers
    (b) Number of chickens per farm
    (c) Eggs produced per farm - dozens
11 - Dairy Products - Percent farms reporting
    (a) Milk - Number of cows (quantity)
    (b) Butter churned on farm
    (c) Butter sold (pounds)
    (d) Cream sold (pounds butter fat)
12 - Animals Slaughtered per farm
    (a) Percent of farms reporting
    (b) Cattle and calves per farm
    (c) Hogs and Pigs
    (d) Sheep and lambs
13 - Vegetable Production for Home Use
    (a) Percent of farms reporting
    (b) Value per farm
14 - Irrigation
    (a) Percent of farms reporting
    (b) Acres irrigated
    (c) Wells pumped
    (d) Prime mover capacity
    (e) Pump capacity
    (f) Average lift

The information contained in Table I should be used by the field representative in discussing with the local authorities and county agents such items as the types of farming, the degree of merchanization, the relative investment between land and buildings and mechanical equipment, and the diversified production which will permit the greatest use of power on farms. Some of this information may at first seem intangible, but with the assistance of county agents and other local authorities, the fieldman will be able to derive from it an indication of the capacity of the inhabitants of an area to accept new ideas and the need or opportunity to incorporate power into their home and farm work.

c. Estimates of Future Saturation of Farm and Home Appliances on the System.

Mention has already been made in (a) above of some of the factors to be considered in determining estimates of average KWH consumption at the end of the initial or two year periods. In making a similar determination of estimates of average KWH consumption at the end of ten years, it will be necessary to arrive at estimates of the percent saturation of appliances which will form the basis for such KWH estimates. The fieldman's judgment of the rate at which the ten-year saturation estimates will be attained will serve as a basis for determining the average KWH consumption to be attained at the end of the five years.

For purposes of arriving at average KWH consumption at the end of ten years, the estimates of percent saturation of appliances should be compiled separately for Domestic and Farm Equipment Usages. The total KWH consumption for farm usages will be the sum of the estimated KWH consumption for domestic and farm equipment usages. Methods of preparing such estimates are outlined below.

(1) Domestic Usage:

In determining the estimated average KWH consumption for domestic usage at the end of ten years, the estimates of percent saturation of domestic appliances need be determined for only those appliances which, in the judgment of the field representative, will account for a major portion of the total KWH usage for domestic applications on a particular system. The remaining domestic appliances may then be grouped into "Miscellaneous Domestic Appliances". The number of KWH to be associated with Miscellaneous Domestic Appliances will depend upon the fieldman's estimate of the various applications which will be included in this category, which in turn is dependent upon what portion

of the total domestic usage is attributed by the fieldman to domestic appliances other than Miscellaneous. For example, if the fieldman determines that domestic appliances other than Miscellaneous will account for 85 percent of the total KWH usage for domestic purposes, then 15 percent will be attributed to usage of Miscellaneous Domestic Appliances. In other words, the KWH usage for Miscellaneous Domestic Appliances should be computed as a function of the total KWH usage for domestic purposes. Thus, in the example above, the total KWH usage for other than Miscellaneous Domestic Appliances would be divided by 0.85 in order to determine the total KWH usage for domestic purposes.

(From analyses of a limited number of systems for which appliance saturation data is available, it appears that the KWH usage for Miscellaneous Domestic Appliances is directly related to the degree of saturation of those domestic appliances which account for a major portion of the total KWH usage for all domestic applications and which we will call the "control group". From these analyses it can be shown that where the percent saturation of appliances in the control group is relatively high, the percent of total domestic KWH usage that can be attributed to their use is approximately 90 to 95 percent; and where the percent saturation of appliances in the control group is low, the percent of total domestic KWH usage that can be attributed to their use is of the order of 80 to 85 percent. In other words, the higher the saturation of appliances in the control group, the lower the percentage of total KWH domestic usage that can be attributed to the use of Miscellaneous appliances. The analyses show that a system having a high saturation of appliances in the control group would also have a high saturation of Miscellaneous appliances such as toasters, waffle irons, fans, food mixers, etc,; however, the percentage that the usage attributed to Miscellaneous appliances is of the total usage for all domestic appliances is relatively low).

It follows from the above discussion that the estimates of percent saturation of appliances as determined for the control group will tend to classify the <u>degree of saturation</u> into what may be called "Low", "Medium" or "High" Class. In order to convey to the field representative the varying degrees of saturation of appliances in the control group which will classify the system into Low, Medium or High, a classification guide is entered below consisting of appliances which have been assumed to constitute the control group.

It should be emphasized that these appliances have been chosen for purposes of illustration only and may not necessarily constitute all the appliances in the control group of any particular system.

CLASSIFICATION GUIDE

Domestic Control Group (Appliance)	PERCENT SATURATION PER 100 CONSUMERS		
	LOW	MEDIUM	HIGH
Lighting	100	100	100
Home Freezers	20 or less	21-50	51-75
Iron	90	90	91-95
Radio	60 or less	61-90	91-125
Range	20 or less	21-50	51-90
Refrigerator	50 or less	51-75	76-90
Washing Machine	75 or less	76-85	86-95
Water Heater	20 or less	21-50	51-90
Water Pump	50 or less	51-70	71-90

	PERCENT OF TOTAL DOMESTIC USE		
GROUP	LOW	MEDIUM	HIGH
Control Group	80-85	86-90	91-95
Misc. Domestic Appl.	15-20	10-14	5-9

In making a determination of the KWH to be associated with Miscellaneous Domestic Appliances, the field representative should first decide whether the percentages of saturation of appliances accounting for a major portion of the total KWH usage for domestic usage places the system in a "Low", "Medium", or "High" class of saturation. Having done this, the choice of the proper percentage that the usage for Miscellaneous Domestic Appliances is of the total usage for domestic purposes becomes more apparent from the classification guide above.

Domestic Appliance (Control Group)	Estimated Percent Saturation Per 100 Consumers (10 years hence)	Average Monthly KWH per Unit Appliance	Total Monthly KWH
Lighting		30	
Home Freezer		75	
Iron		5	
Radio		8	
Range		100	
Refrigerator		35	
Washing Machine		3	
Water Heater		240	
Water Pump		20	
		SUB-TOTAL	
Miscellaneous Appliances @ % of Total			
TOTAL			
Average Monthly Domestic KWH Consumption/Member			

The above table is included to further illustrate the method of determining average domestic KWH consumption. Here again the appliances chosen are the same as those entered in the classification guide above and may not necessarily constitute all the appliances in the control group of any particular system.

The control group of appliances listed above would, in this hypothetical case, constitute the domestic appliances accounting for a major portion of the total farm domestic KWH usage on a particular system. Having arrived at the percent saturation per 100 consumers, for each of the appliances listed, it is then necessary to determine the total monthly KWH usage for each appliance per 100 consumers, based on accepted standard usages per unit appliance. By addition the Sub-Total is found, this sum representing the major portion (KWH) of the total KWH usage for domestic purposes. From an examination of saturation percentages, it is then determined whether the

system would fall in a "Low", "Medium", or "High" class of saturation. Based upon the latter decision, the choice of the proper percentage to be applied in arriving at the total KWH for Miscellaneous Domestic Appliances per 100 consumers can be made.

For the purposes of illustration, assume that in the above example the system is determined to have a "Medium" saturation of appliances which account for a major portion of domestic usage and that the Sub-Total KWH consumption for these appliances is 20,000 KWH per 100 consumers based on the estimated percentages of saturation. Assume further that a determina- of 86% has been made to represent the above Sub-Total, leaving 14% of the total usage attributable to the use of Miscellaneous Domestic Appliances. Then,

86% = 20,000
1% = 20,000 ÷ 86 or 232.5
14% = 14 x 232.5 or 3255

In the above illustration, 3255 KWH would represent the KWH usage per 100 consumers for Miscellaneous Domestic Appliances, which, added to the previous Sub-Total of 20,000 results in a total of 23,255 KWH per month per 100 consumers for total farm domestic usage. The estimated average monthly consumption per consumer for domestic usage ten years hence, is therefore 232 KWH.

(It is pointed out that the above example is for purposes of illustration only.)

(2) Farm Equipment Usage:

The percent saturation of farm equipment appliances should be carefully considered in connection with farm production as indicated in Table I. Referring to the table, it is seen that farm production is grouped into principal categories such as Small Grains, Silage, Livestock, Poultry, Dairy Products, Animals Slaughtered, and Vegetable Production for Home Use. The field representative should pay particular attention to the quantity of production in each category and the number of farms reporting such production, etc. Using this information as guidance, along with other basic data, the fieldman should prepare a list of appliances which will most likely prevail in use in a county or community experiencing such agricultural production. Such a list of appliances should include only those appliances which will account for a major portion of the total KWH usage for farm equipment (control group) just as was done in determining

domestic farm usage in c(1) above. For instance, under "Poultry Production" (if such is significant in the area) the fieldman would include in such a list Poultry House Lighting and Chicken Brooders; under "Dairy Production" one would list Milking Machines and possibly Milk Coolers and Dairy Hot Water Heaters in a significant dairying area; and Hog Brooders would be listed in connection with hog production, etc. Such a list of farm equipment items, when completed, would indicate the appliances of farm equipment which would account for a major portion of the total KWH usage for farm equipment appliances and would comprise the control group. The next step is to determine the percent saturation (10-years estimate) of these various appliances. This will be done by a careful judgment of the relationship between the number of farms to be served and the number of such farms reporting various agricultural production items, or farms capable of such production. Consumption estimates to be associated with each appliance should be directly related to the quantity of production per farm as indicated by the standard KWH estimates contained in Appendix D.

The remaining farm equipment items may be grouped into "Miscellaneous Farm Equipment Appliances" and treated in much the same manner as was done above in estimating KWH consumption for Domestic Appliances. The KWH to be associated with Miscellaneous Farm Equipment Appliances may be computed as a function of the total KWH estimated for farm equipment usage, based on a percentage chosen in exactly the same manner as for Domestic Usage in c(1) above.

Table II indicates the method of preparing estimates of percent saturation as applied to Farm Equipment Usages.

d. KWH Consumption for Non-Farm Residential Consumers:

A similar application of the method of determining domestic farm usage as described in c(1) above should be used in arriving at KWH consumption for non-farm residential consumers ten years hence.

e. KWH Consumption of Small Commercial Consumers:

Determination of the average KWH consumption applicable to small commercial consumers for each of the periods of two, five and ten years should be based on all information available to the field representative making the survey. Such determinations will depend upon the types of commercial

TABLE II

ESTIMATED FARM EQUIPMENT USAGE

10 Year Estimates

APPLIANCE	Percent Saturation Per 100 Consumers	Average Yearly KWH Per Unit Appliance	Total Yearly KWH
(1) Farmstead Lighting			
POULTRY PRODUCTION			
(2) Poultry House Lighting			
(3) Brooders			
(4) Water Warmers			
DAIRY PRODUCTION			
(5) Milking Machine			
(6) Dairy Water Heater			
(7) Milk Cooler			
HOME MEAT AND FOOD PRODUCTION			
(8) Freezer Chests			
(9) Garden Watering			
(10) Pig Brooder			
ROUGHAGE CROPS			
(11) Hay Choppers			
(12) Hay Driers			
(13) Ensilage Blowers			
(14) Chopped Hay Blowers			
(15) Ensilage Cutters			
GRAIN CROPS			
(16) Grain Blower			
SUB-TOTAL	______	______	______
(17) Miscellaneous Farm Equip. @ ___% of Total			______
TOTAL			______
Average KWH Consumption Per Month Per Member for Farm Equipment			______

establishments prevailing in the area, the kind of business engaged in, and other factors directly related to power consumption of this class of consumer. The most reliable method now used to estimate future kilowatt-hour consumption of commercial consumers is an extrapolation of trends based on historical information. It should be noted that commercial usage is much less responsive to rate changes than domestic usage. Systems which retain power use specialists to conduct education activities among commercial consumers, however, have shown significant increases. Therefore, the amount of power use activity expected on the part of the borrower should be taken into consideration.

f. <u>KWH Consumption for Seasonal Cottages:</u>

KWH consumption for seasonal cottages will vary depending upon the length of time the cottages are in use, the variety of appliances used and other factors affecting power use for recreational purposes. In most cases, average KWH consumption of seasonal cottages may be expected to be below that of non-farm residential consumers. Determination of the average KWH consumption among seasonal cottages should be made after a thorough investigation of all factors having a bearing on power consumption of recreational users. The basis for such estimates together with supporting information should be clearly stated.

g. <u>Other Factors:</u>

Other factors which shall be given consideration in the determination of the estimated average consumption for farm, non-farm, and small commercial consumers are:

(1) Experience of operating systems in areas similar in economic and productive characteristics;

(2) The application of electric power to productive use determined by the prevailing types of farming and other related enterprises existing in the area;

(3) Effect of electric service toward the stimulation of new enterprises, and other economic activities in the community;

(4) The general progressiveness of the farm people and their willingness to adopt new methods and techniques with the use of electricity in farming operations; and,

(5) The influence of low wholesale power rates, including the amount of the minimum bill.

2. KW Unit Demand Values for Farm, Non-Farm (Residential), Small Commercial, and Seasonal (Summer Cottages) Consumers.

Fortunately, the matter of determining the estimated average KW demand per consumer at peak load has been simplified since operating records of REA borrowers have provided a fair indication of what the peak demand of a given number of consumers having a given monthly average consumption will be. This information has been condensed into Maximum Demand Curves attached as Appendix C. These curves shall be used as a basis for estimating the peak demand of a group of consumers for load study purposes. As an example of the use of the Maximum Demand Curves, assume that the system under consideration is estimated to be serving 1000 farm consumers with an average consumption of 200 KWH per month at the end of two years. Beginning at the bottom of the chart on the vertical line corresponding to 1000 consumers, follow upward along this line to the point of intersection of the vertical line with the curve corresponding to 200 KWH, then horizontally to the left to read 780 kilowatts peak demand on the left hand side of the chart. From this it is seen that the peak demand (or maximum demand) of 1000 farm consumers using an average 200 KWH per consumer per month would be 780 kilowatts, or an average demand per consumer of 0.78 kilowatts at peak load. Similar estimates of the maximum demands of groups of consumers ranging from 5 to 5000 consumers with average usage of from 40 to 500 KWH per consumer per month may be obtained from these curves. Values outside the range of the chart may be estimated by extending the curves, however, it is felt that this will rarely be necessary.

Since these curves were prepared from averages of a large number of systems in actual operation, the diversity of usage between consumers of the same type is already reflected in the values obtained from the chart so that it is not necessary to apply a diversity factor in arriving at the maximum demands of these classes of consumers.

Determination of average demands for the five and ten year periods may be arrived at from the curves in the same manner as shown for the two year period.

The Maximum Demand Curves shall also be used in determining the maximum demands of non-farm (residential), small commercial and seasonal consumers. The use of the curves in making such determinations is the same as that explained above for farm consumers.

Since load studies are designed to show the power requirements of each section of a system which is or will be served by a separate point of delivery of wholesale power, it is important that the number of each class of consumer and the average monthly consumption in specific areas be associated with the respective power delivery area in using the Maximum Demand Curves.

B. 1. KWH Consumption and Maximum Demands (KW) of Rural Industries.

Power requirements of rural industries will vary with the kinds of industries, the quantity and kind of products produced, the type of manufacture, method of operation, and numerous other factors pertinent to the particular industrial establishment under study. For this reason, each industrial establishment becomes an item for individual treatment in load study determinations. In such treatment it will be necessary for the field representative to contact the owners or operators of the various industrial plants served or to be served by the system. On existing industrial establishments the field representative will be able to determine from the owners the kind of power now used, the amount of electricity used or necessary to be used in doing the same work, the number and size of motors required, and other information on which estimates of power may be used.

Future industries which may be expected to be developed in connection with the development of natural resources may be included in the power requirements of a system if there is reasonable assurance and justification that such industries will be developed and served by the system. In such cases, the power requirements of similar existing industries in the area may be used as a basis for estimating the power requirements of such future industries.

Though as indicated above, the power requirements of each industrial plant will depend upon analysis of a number of factors affecting the individual plant, some "rule-of-thumb" methods of determining approximate power requirements are listed below and may prove helpful in the absence of specific information concerning the establishment under study.

a. Sawmills:

Sawmill power demands have been estimated on the basis that one kilowatt will be required for each 100 board feet of rated daily output of the mill. For example, a sawmill having a daily output capacity of 25,000 board feet would have a connected load of approximately 250 kilowatts. Similarly, power requirements (KWH) have been estimated on the basis that 35 KWH are required to produce 1000 board feet of lumber. On this basis a sawmill with an output of 25,000 board feet per day would have an average daily power consumption of 875 kilowatt-hours (25 x 35). For well established mills, annual consumption may be based on an average operating season of 200 days per year.

b. Shingle Mills:

The KW demand of shingle mills may be estimated on the basis that 4.5 kilowatts connected load is required for

each square of daily output and power consumption at 7 KWH per square of daily output. Annual power consumption is based on the average number of days per year the mill will operate.

c. Planing Mills:

Planing mill demands have been estimated on the basis that one kilowatt is required for each 400 board feet of daily output; power consumption at 10 KWH for each 1000 board feet processed daily.

d. Pole Treating Plants:

Pole treating plant demands have been based on a required capacity of 2 kilowatts per pole output per day and power consumption at 5 KWH per pole daily output.

e. Grain Elevators (Commercial):

Commercial grain elevators as commonly found in rural and village areas have been estimated to have demands of 10 to 15 KW and power consumption of approximately 10,000 KWH annually. Determination of actual loads would depend upon conditions pertinent to each such establishment.

f. Poultry Hatcheries:

The average commercial hatchery has been estimated to have a maximum demand of 10 kilowatts and an average annual consumption of approximately 70,000 kilowatt-hours. Here again actual conditions will govern the power requirements.

g. Cold Storage Plants:

It is estimated that the average cold storage plant will have a maximum demand of 10 to 15 kilowatts, resulting in an average annual consumption of approximately 30,000 to 36,000 KWH. Loads of individual plants will vary and each will depend upon local conditions.

h. Telephone Repeater Stations:

Estimates of 5 kilowatts demand and 20,000 KWH annually have been used for repeater stations.

i. Air Beacons:

The average airway beacon will have a demand of approximately 2 kilowatts and an annual consumption of approximately 6,000 KWH to 8,000 KWH.

C. 1. KWH Consumption and KW Demands of Irrigation Pumps:

a. Pump Irrigation:

From the basic data collected on pump irrigation in the area, the fieldman will be able to arrive at the number and size of pumps and their approximate location in the area under survey. He will also have determined approximately how many hours per season each pump will operate. The KWH consumption per pump per season is found by multiplying the size of the pump in horsepower by the number of hours per season the pump operates. (For all practical purposes in load study work one horsepower may be assumed to equal one kilowatt of connected load).

For example, assume that the predominant size of pumps in an area is found to be 15 horsepower and that each pump will operate 1000 hours per irrigation season. Each pump will have a maximum demand of approximately 15 KW and will consume 15,000 KWH (15 x 1000) annually for irrigation pumping.

Since all pumps may not be in operation at the same time in a given area, and furthermore, since some diversity may be experienced between irrigation and other type loads, a diversity factor may be used in arriving at the demand that irrigation consumers contribute to the total system demand. Diversity factors should be determined after carefully considering the effect of irrigation loads on the total load of the system.

Example: Assume that 100 pumps are estimated to be served by the system in 10 years and that the average size of pumps will be 15 horsepower. The maximum demand of 100 pumps of this size would be approximately 1500 KW if all pumps operated at the same time and if there was no diversity between pump load and other loads on the system. Applying a diversity factor of 1.5 to the total connected load of 1500 KW, the estimated maximum demand of the 100 irrigation pumps becomes (1500 divided by 1.5) or 1000 KW. (Additional discussion concerning pump irrigation loads may be found on pages   to   of Appendix B).

b. Sprinkler Irrigation:

A conservative rule-of-thumb which can safely be followed in estimating sprinkler irrigation loads is that one horsepower will irrigate 4 to 5 acres of land where water lifts do not exceed 50 feet. The KWH consumption per pump will depend on the number of hours the pump is operated or the amount of water to be discharged.

Example: A 20 acre field is irrigated by a 5 horsepower pump, capacity 100 gallons per minute, operating at a 100-foot total head. (Total head includes "static head", plus "equivalent head" to maintain 30 to 40 lbs./sq. in. pressure, plus "friction head"). There are 11 sprinkler heads operating, each supplying 9 gallons of water per minute. This layout will supply 22 inches of water to the 20 acre tract by pumping 2000 hours. The same layout will supply 11 inches of water to the 20 acre tract by pumping 1000 hours. The power required to operate the pump would be 10,000 KWH and 5,000 KWH, respectively, for 2000 hours and 1000 hours operation.

The KW demand per pump will depend on the size of pump required which is in turn directly related to the required amount of water to be delivered under specified conditions. Diversity factors of the order of those used in "pump irrigation" above may also be applied in arriving at overall power demands for sprinkler irrigation.

D. 1. KWH Consumption and KW Demands of Electric House Heating Consumers.

a. Space Heating:

Tests conducted on space heating in the Northwest indicate that the average connected load of this type of house heating installation is approximately 15 KW per installation. The average demand of several such installations on a system has been found to be approximately 11 KW per installation.

The annual power consumption for a space heating installation will vary, depending on the size of the house, climatic conditions, house construction, living habits, etc. The average annual power consumption for a typical installation is probably about 11,000 KWH for the less severe climates of the Northwest to 17,000 KWH for more severe conditions.

In arriving at the demand that several space heating installations may contribute to the overall system peak demand, a diversity factor of approximately 1.5 will usually be applicable. This reduces the overall demand of house heating installations to approximately 7.33 kilowatts (11 KW divided by 1.5) per installation.

It is obvious that considerable diversity would exist between space heating and irrigation. Space heating would occur in the winter months and irrigation in the summer months. Therefore, where both of these types of loads exist on the system, only the larger of the two should be considered in arriving at peak demands of the system. The power consumption (KWH) of both types of loads would not be affected.

b. Reverse Cycle Refrigeration (Heat Pump):

Sufficient test data are not available on this type of house heating and air conditioning installation to accurately determine power consumption and demands. From the type and size of electrical equipment involved, it appears that the maximum demand of an individual installation will be approximately 4 KW. Power consumption for year around air conditioning will in all probability compare favorably with power requirements of space heating installations.

In the Southeast Region, consisting of all or parts of Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Florida, and Mississippi, the Federal Power Commission in a recent report states: "The amount of electric energy to be used by the heat pump in the Southeast Region for air-condition, house heating, and water heating, based on very preliminary data, is estimated at 6,300 kilowatt-hours a year for the average customer --- In heat pump calculations, assuming continued improvements in refrigerant, compressors, and heat-exchange equipment, the adopted estimate of 6,300 kilowatt-hours for an average five-room house corresponds to an annual use of 3,400 kilowatt-hours per year for house heating, 1,700 kilowatt-hours per year for air-conditioning, and 1,200 kilowatt-hours per year for electric water heating."

E. 1. Power Consumption and KW Demands of Acquired Properties:

Energy requirements and KW demands of proposed acquisitions should be estimated for each period of the estimates during which the property will be served by the system. Operating data will in most cases be available either from the present operators or from reports to regulatory bodies. Present KWH consumption and KW demands should be used as a basis for estimating future power requirements of acquired properties. In cases where only partial records are kept, the field representative may use his own estimates to complete the required data.

Example: Assume that a system under consideration for acquisition sold 200,000 KWH to its consumers in 1946. No records are available which would indicate the extent of line loss or of KW demand. In order to complete the information required, assume say 20 percent system losses. The total annual power requirement, including system losses, would be 250,000 KWH or (200,000 divided by 80 multiplyed by 100). Assume further that the annual load factor was 45 percent. The KW demand may then be computed as follows:

$$8760 \times .45 \times \text{KW demand} = 250,000$$

$$\text{KW demand} = \frac{250,000}{8760 \times .45} \text{ or } 63 \text{ KW}$$

Having determined the present power requirements, estimates of future requirements may be based on this and other factors relating to the acquisition property.

In the case of completed or pending acquisitions, the estimates for each period should be broken down to show the number of consumers served together with corresponding estimates of KWH requirements and KW demands by classes of consumers. Such a breakdown should be furnished for each town or community served by the acquisition property. Farm or other consumers served by a completed or pending acquisition and located outside any town or village may be included with other such consumers served by the REA-financed system under study.

F. 1. KWH Consumption and KW Demands of "Other Consumers":

Determination of the power requirements of this class of consumer will depend upon the type of consumer included in this class and related factors affecting the use of power by such consumers. The field representative may find previous suggestions pertaining to the more common classes of consumers helpful in such determinations.

G. 1. System Losses:

System losses are as important in determining power requirements of a system as the power requirements of individual consumers. Indication of present system losses may be obtained from operating records of a system. Since losses as a rule may be expected to decrease with system improvements and increased power utilization by consumers on the system, estimates of system losses should be determined for each period of the estimates.

Example: After analyzing the various factors affecting system losses, the fieldman may conclude that system losses on a particular system will approximate 22 percent at the end of two years, 20 percent at the end of five years, and 18 percent at the end of ten years.

System losses should be added to the sum of the annual power requirements of the various classes of consumers in each delivery area. As an example of the method of computing line loss, assume that the system (or section of a system) total power requirement for a given year is 1,560,000 KWH, excluding system losses, and that system losses are estimated at 22 percent. Then,

$$78\% = 1{,}560{,}000 \text{ KWH}$$

$$1\% = 1{,}560{,}000 \div 78 \text{ or } 20{,}000$$

$$22\% = 22 \times 200{,}000 = 440{,}000 \text{ KWH}$$

In this example, 440,000 KWH would represent system losses. The total energy requirement for the year would be 1,560,000 plus 440,000 or 2,000,000 KWH.

H. 1. <u>Summary:</u>

In this Section the methods of arriving at KWH consumption and KW demands have been outlined for the various classes of consumers which will be commonly served by REA-financed systems. System load study reports will contain tables of such load estimates which will be compiled for each section of the system served or to be served by a separate point of delivery of wholesale power.

Table III is included in order to illustrate the method of tabulating load estimates.

TABLE III

LOAD ESTIMATES - DELIVERY POINT ___

(System Designation

TYPE OF CONSUMER	NO. OF CONSUMERS			MAXIMUM KW DEMAND			ANNUAL KWH REQUIREMENTS		
	1948	1951	1956	1948	1951	1956	1948	1951	1956
Farm									
Non-Farm									
Seasonal Cottages									
Commercial									
Etc.									
SUB-TOTALS									
PLUS ESTIMATED SYSTEM LOSSES									
SYSTEM TOTALS - D. P.									

III. PREPARATION OF SYSTEM LOAD STUDY REPORT

It is desirable that the preparation and assembly of load study reports by fieldmen be as uniform as possible and that the information be submitted in a manner more or less standardized. There has already been discussed in Section II considerable basic data which should be embodied in a report of an area under study. Likewise, in Section III have been set forth basic principles and methods whereby estimates of loads may be determined. It now remains for the fieldman to incorporate into an overall report his estimates of the future power requirements, all of which should be consistent with and supported by basic data pertaining to the area under study.

The title of all load study reports should be as follows:

SURVEY AND REPORT
OF
PRESENT AND FUTURE POWER REQUIREMENTS
OF
(Name of Borrower)

The following "Table of Contents" may serve as an outline in the preparation of load study reports. The field representative may wish to make additions in an appropriate section in order to include information not covered by this outline.

TABLE OF CONTENTS

Each major topic or sub-topic in the above outline should be fully developed to include all major points of information pertaining to the area or system and related to the load study. These topics are further explained and elaborated on in subsequent discussions of this Section.

A. Purpose of Report:

The purpose of the load study and report should be set forth briefly under this heading. The primary purpose of all load studies is "to evaluate the prospects for electrical power consumption by existing and potential consumers of an REA-financed borrower and to estimate the probable power requirements of the borrower's system at the end of the next two, five and ten years". Other purposes as outlined in the Introduction to this manual may be included under this heading if such purposes are applicable to the study.

The following statement (or equivalent one) should be included in all load study reports under the heading "Purpose of Report":

> "This study does not purport to establish the economic feasibility of the borrower serving all loads tabulated in the survey nor does it intend to imply that funds are or will be earmarked by the Rural Electrification Administration for service to such loads. Each application for REA loan funds will, as in the past, be considered on its own merits".

B. Summary and Conclusions:

Major points and conclusions as revealed by the survey should be summarized briefly in this section of the report. Maximum demands and total KWH requirements of the system should be pointed out for each period of the estimates. The number of consumers to be served by the system in two, five and ten years may be shown. Ultimate mileage to serve all consumers included in the survey should be mentioned together with the estimate of ultimate system investment. Pertinent facts regarding the present or proposed power supply for the system should be included. Other important facts or conclusions as uncovered by the field representative may well be mentioned in this section of the load study report.

C. Method of Survey and Sources of Information

In this section should be discussed the detailed steps and procedures followed by the field representative in completing the load survey. Sources of important information included in the report should be mentioned as should any assistance afforded by local offices of various county, state or federal agencies. Data collected on specific types of loads should be associated with the source, such as "valuable information pertaining to irrigation in the area was furnished by the U. S. Geological Survey" or "information pertaining to sawmills and sustained yield in lumber production in the area was obtained from officials of the Forest Service".

The following statement (or equivalent one) should be included in this section of the field representative's load study report:

> "Since time and available personnel did not permit a more detailed survey than has been made, the load estimates represent a judgment arrived at through experience and an evaluation of the factors affecting the future use of electricity in rural areas".

D. Basic Data Relating to Load Estimates

This section of the fieldman's report should contain a narrative account of the basic data on the area and system as outlined in Section II of this manual. This basic data will serve to support and justify the field representative's judgment in his determinations of the potential power requirements of the system. All loads included in the subsequent section of the load study report entitled "Types of Loads to be Served" should have a foundation for them in this section of the report.

The information included in this section may well begin with a description of the physical characteristics of the area, followed by a well organized presentation of the agricultural, industrial and other activities of the area. The use of statistical information in support of past production or other activity should be included wherever it is possible to obtain such data. This applies especially to farm production and farm income as reported through Census data.

It should be emphasized that this section of the report is of major importance and will require careful preparation and thoroughness in order to eliminate questions which may arise in connection with the estimates of loads.

E. Source of Energy Supply

This section should contain a brief statement of the present or proposed source of power supply, location of point(s) of delivery, average cost per KWH of wholesale energy, adequacy of power supply, and a short description of facilities from which power is obtained by the borrower. In cases where it is expected that power from a public power agency will be supplied the system at some future date, approximate load centers and tentative points of delivery of public power should be indicated. The wholesale rate which will be made available by the public power agency should also be mentioned.

F. Other Utilities

All electric utilities and power companies operating in the area of the REA borrower should be included in this section of the load study report, together with an enumeration of the towns served and

the extent of service to rural areas. A brief description of generation and transmission facilities of such utlities should be included. Similar information should be shown for facilities of any public power agency that may operate in the area. Municipal systems and their scope of service should be mentioned as should systems of other REA borrowers operating adjacent to the system under study.

G. Rates

The published retail rate schedules covering rural, residential and small commercial service should be included for each utility, power company or municipality operating in the area served by the system under study. Similar retail rate schedules of the borrower should be shown for comparison and to illustrate competitive retail rates in effect throughout the area. Retail rates of REA borrowers operating in adjacent areas need not be shown unless difference in rates has created a competitive situation between borrowers.

H. Types of Loads to be Served

In this section the various classes of consumers to be served by the system should be enumerated separately as illustrated in the foregoing outline of "Table of Contents". The method and procedures followed in determining KWH consumption and KW demands of each class of consumer, or individual consumers, should be clearly shown. Past operating data on KWH consumption may be cited or tabulated for various classes of consumers now served by the system in order to serve as the basis for certain estimated future loads. The fieldman should attempt to develop estimates of consumption and demands in this section following the suggested methods outlined in Section III of this manual.

I. Estimates of Loads

This section of the report should deal with the method of tabulating loads, division of territory with respect to power delivery points, and the association of specific "Tables of Load Estimates" with specific delivery points. The method of applying diversity factors to loads shown in the Tables should be explained in order that the estimates of KW demand in the Tables may be clearly understood. (For example, @ 30/2F refers to an estimated connected load of 30 kilowatts of an individual consumer and an overall diversity factor of 2, which represents the demand factor of the individual load, plus diversity between loads of the same type and overall diversity between loads of different types when connected to the system).

Following this section of the report should come the Tables of Load Estimates - Table I, II, III, etc. A Table of Load Estimates should be made for each delivery point proposed for the system. A Table, "Summary of Load Estimates" should then be prepared reflecting the combined energy requirements of the system at all delivery points.

J. Estimated Ultimate System Investment

An estimate of the ultimate system investment to serve all consumers tabulated in the load estimates should be prepared by the field representative. To illustrate the method of arriving at such an estimate, the following excerpt is quoted from a previous load study report on an Idaho cooperative:

"To arrive at a fair basis upon which a long range rate structure may be considered, it is necessary to arrive at an approximation of the ultimate investment in distribution lines which the cooperative must make.

"Drawing No. 1 shows the present system, plus all foreseeable extensions that may be made within the next decade. A reasonable estimate of total miles of line may be arrived at on a density basis to which should be added the independent mileage which will be necessary to serve isolated 3-phase power loads, such as sawmills, mines, etc., and irrigation pumps.

"Tables I and II reflect that a total of 1,175 farm, 90 non-farm, 900 seasonal and 110 small commercial consumers will be served by the cooperative by 1956. On the basis of an ultimate consumer density of 2 per mile for farm and small commercial consumers, and 7 per mile for seasonal and non-farm consumers, the following tabulation reflecting total ultimate miles of line is made:

Farms and Commercial consumers	$\frac{1285}{2}$	=	643 miles
Seasonal and non-farm consumers	$\frac{990}{7}$	=	142 miles
Isolated sawmills, mines, etc(dwg.#1)		=	12 miles
Irrigation pumps(av. .3 miles each)		=	30 miles
Total			827 miles
Miscellaneous (approximately 3%)			23 miles
Grand Total			850 miles

"A large percentage of this mileage will be comprised of 3-phase line in order to furnish adequate service to large consumers and to assure proper voltage regulation and balance of load on the system. Map mileages, reflected on Drawing No. 1, were scaled and the following estimates of 3-phase, V-phase and single-phase lines were made:

Estimated 3 - phase line	=	125 miles
Estimated V - phase line	=	60 miles
Estimated 1 - phase line	=	600 miles
Estimated services	=	65 miles
Total		850 miles

"The following calculation of ultimate investment of the cooperative is based on line construction costs somewhat below prevailing contract prices in order to arrive at an average cost of construction between present day and prewar levels:

3-phase line	125 miles @ $1400	-	$ 175,000
V-phase line	60 miles @ $1100	-	66,000
1-phase line	600 miles @ $ 900	-	540,000
Services	65 miles @ $1000	-	65,000
Total Distribution Lines			$ 846,000
Meters, etc., 2398 @ $15		-	$ 36,000
Acquisitions (Worley and Harrison)		-	24,500
Office furniture and fixtures		-	5,000
Transportation equipment		-	5,000
Office building		-	20,000
Laboratory equipment		-	1,000
Communication equipment		-	4,000
Miscellaneous tools and equipment		-	2,000
Total			$ 97,500
General Overhead:			
Organization expense - 2398 @ $5		-	$ 12,000
Miscellaneous construction expense - 2%		-	19,000
Engineering & Supervision - 5%		-	48,000
Legal expense - approximately 1%		-	9,500
Taxes during construction - approx. 2%		-	19,000
Total - General Overhead			$ 107,500
Sub-Total			$ 1,051,000
Contingencies (approximately 5%)			53,000
Grand Total Investment			$ 1,104,000

K. Maps

A copy of the completed unelectrified farm survey maps should accompany the system load study report when the report is forwarded by the field representative to headquarters. These maps should show all information provided for in the procedures outlined in Appendix A. Proposed lines of the system need not be shown on the unelectrified farm survey maps.

The field representative should make sure that all existing large power loads in excess of 10 KVA are shown on the maps; also future power loads should be shown and identified if their location is reasonably certain. Any variation of factors related only to particular areas of the system should also be delineated on the unelectrified farm survey maps. Such variations may include areas which may be expected to achieve a considerably higher or lower KWH consumption per month than the average consumption of the system, such

as an area predominately recreational in character, etc., or an area in which irrigation is practised or is expected to develop.

In addition to the above information, proposed delivery areas and delivery points for wholesale power should be designated on the maps. In cases where System Engineering Studies have been made or are in progress, the borrower's engineer can be of great assistance to the field representative in determining proposed delivery areas and delivery points for wholesale power. The project engineer may often furnish maps and other data which will be useful to the field-man making the survey.

APPENDIX A

(Inventory of Unelectrified Farms)

INVENTORY OF UNELECTRIFIED FARMS

Procedure

The purpose of the inventory is to locate every rural residence, commercial or industrial establishment without central station electric service as of the date of the survey. The availability of service is not a factor to be considered. All unserved homes and establishments are to be spotted on maps regardless of their proximity to existing distribution lines--of all private utilities, public utilities and REA systems.

The inventory must be conducted on an "optimum boundary" basis. Since most maps are set up by counties, it may be necessary for a borrower to survey all or parts of several counties in order to cover all of the area included in its proposed or established boundaries.

No effort should be made to draw proposed electric lines on the inventory maps. Only lines actually constructed should be shown.

This inventory can be conducted by local REA systems. Test counties surveyed by personnel of borrowers show an approximate cost of 15¢ per mile of road surveyed and mapped.

Procedure - Selection of Base Maps

I. Select the type of county map to be used for the inventory throughout the project area.

   A. Maps obtained from State Highway Commissions or State Planning Boards will generally suffice.

   B. Advise project officials the source of available maps and cost of each. Recommend purchase of at least 3 copies of each county map in the present and proposed service area.

II. With reference to these suggestions, outline the procedure to be used by borrowers in conducting inventory and provide each superintendent or manager with a complete set of instructions. Survey procedure suggested below should be used.

III. Prepare a list of counties or parts of counties to be inventoried by each system.

   A. Where two or more borrowers have lines in the same county, each should survey that part of the county within the optimum area of the respective borrower's system.

IV. Obtain approval of the system's Board of Directors to undertake the survey.

V. Each REA borrower is expected to pay the cost of the inventory in those counties included in the project area.

  A. This cost is to be paid out of general funds, which can be reimbursed when said costs are later included in pre-allotment expense of subsequent applications.

<u>Procedure - Superintendents or Managers</u>

I. Selection of survey workers.

  A. Immediately after receiving maps project superintendent or manager shall make a selection from the system personnel to conduct the survey. The selection may be made from the following:

    1. Superintendent or Manager if he has time for this additional work.

    2. Home Electrification Specialist.

    3. Right-of-way easement solicitor.

    4. Board of Directors.

    5. Lineman.

II. Base map shall be checked for accuracy. In most counties this check can be made with the help of the County Agent and the AAA Committee men, and use of aerial photo maps.

  A. Most base highway maps show the location of rural homes and other rural establishments. The map legend is sufficiently complete so that the type of establishment, i.e., home, church, school, etc., can be identified.

III. After the map is corrected, all energized distribution lines and transmission lines should be drawn on the map. These lines should be easily identified by corresponding legend.

  A. Information now available for locating the existing power lines on the map in the cooperative office, utility offices or from Public Utility Commissions, should not be wholly relied upon due to considerable rerouting of lines, inadequate records, etc. Where there is any doubt whatsoever, a field check should be made to confirm actual location of these lines.

IV. With base maps corrected, actual field work can be held to a minimum.

A. All unserved rural establishments along energized lines (REA system and private utility) should be shown on the map with the proper designation.

B. The location of all loads requiring the installation of more than 10 KVA installed transformer capacity, whether such loads are presently unserved or now being served by the system, should be shown on the map.

C. All rural establishments not along an existing distribution line can be assumed to be unserved and should be so shown on the map.

D. In locating unserved rural establishments, it is often possible to find residents of long standing in a given community who can spot all unserved residences of a given Township on a map without the necessity of driving all roads in the Township. Survey workers should be urged to take advantage of all such opportunities.

E. Survey workers should also be urged to take full advantage of aerial photo maps and other assistance that can be rendered by County Agents and AAA offices in locating unserved rural establishments.

V. Preparation of Maps

A. Base maps of uniform scale and legend must be used for all counties.

B. In adding to the map data and information resulting from the inventory, a legend that is uniform must be used.

1. If the maps are to be duplicatedby mechanical methods, an all black legend must be used.

2. Complete legend must be indicated clearly in the lower corner of each map.

3. A borrower who has invested in a complete Inventory of Unelectrified Farms should not stop there, but make necessary arrangments for complete system mapping in accordance with REA Standards for REA Mapping, Form Adm-49 and Engineering Memorandum 154, dated June 20, 1945.

C. The attached sample map and "Legend" illustrate the manner in which Highway Planning Survey Maps may be adopted to use in unelectrified farm surveys.

D. Disposition of Maps

1. The completed base maps of the survey should be kept in the borrower's files.

2. Preparation of detailed unelectrified farm maps or area coverage maps, as the case may be, of the area should be authorized and the tracing preserved by the borrower. Future pre-allotment maps in connection with subsequent applications for loans will then involve the simple task of drawing the proposed lines on tracing and making the required number of prints.

VI. General

A. Inventory to be conducted without regard to lines under preallotment survey, already surveyed, allotted, or under construction contract. This is an inventory of all rural homes and establishments not receiving central station service on the day of the inventory.

B. The information indicated in the Legend on the attached sample map is all that is necessary for unelectrified farm survey maps. Any additional information the manager or superintendent may desire to include for his own purpose, such as names of unserved individuals, etc., may be shown on the map that is to be retained in the project office.

C. This Inventory of Unelectrified Farms is not to be construed as "area-coverage sign-up" survey. No membership fees or easements are solicited by the survey workers. However, if an area coverage sign-up survey is contemplated in the near future, the borrower may decide to proceed with the Area Coverage Sign-up Survey in which case there would be no need for undertaking an unelectrified farm survey.

LEGEND

Existing Cooperative Line

Existing Private Utility Distribution Line

Existing Private Utility Transmission Line

Prospective Consumer ○

(For unelectrified farm field surveys, the above Legend may be superimposed on Highway Planning Survey Maps as shown on Sample Map)

Representative Symbols Used On
Highway Planning Survey Maps

	In Use	Vacant
Farm Unit		
Dwelling (other than farm)		
Row of Dwellings		
Hospital		
School		
Church		
Hotel		
Summer Dwelling		
Store or small business establishment		
Cemetery		
Power Plant		

Triangulation Station △

County Seat

State Capitol

Road

Railroad

Highway Bridge

Overpass

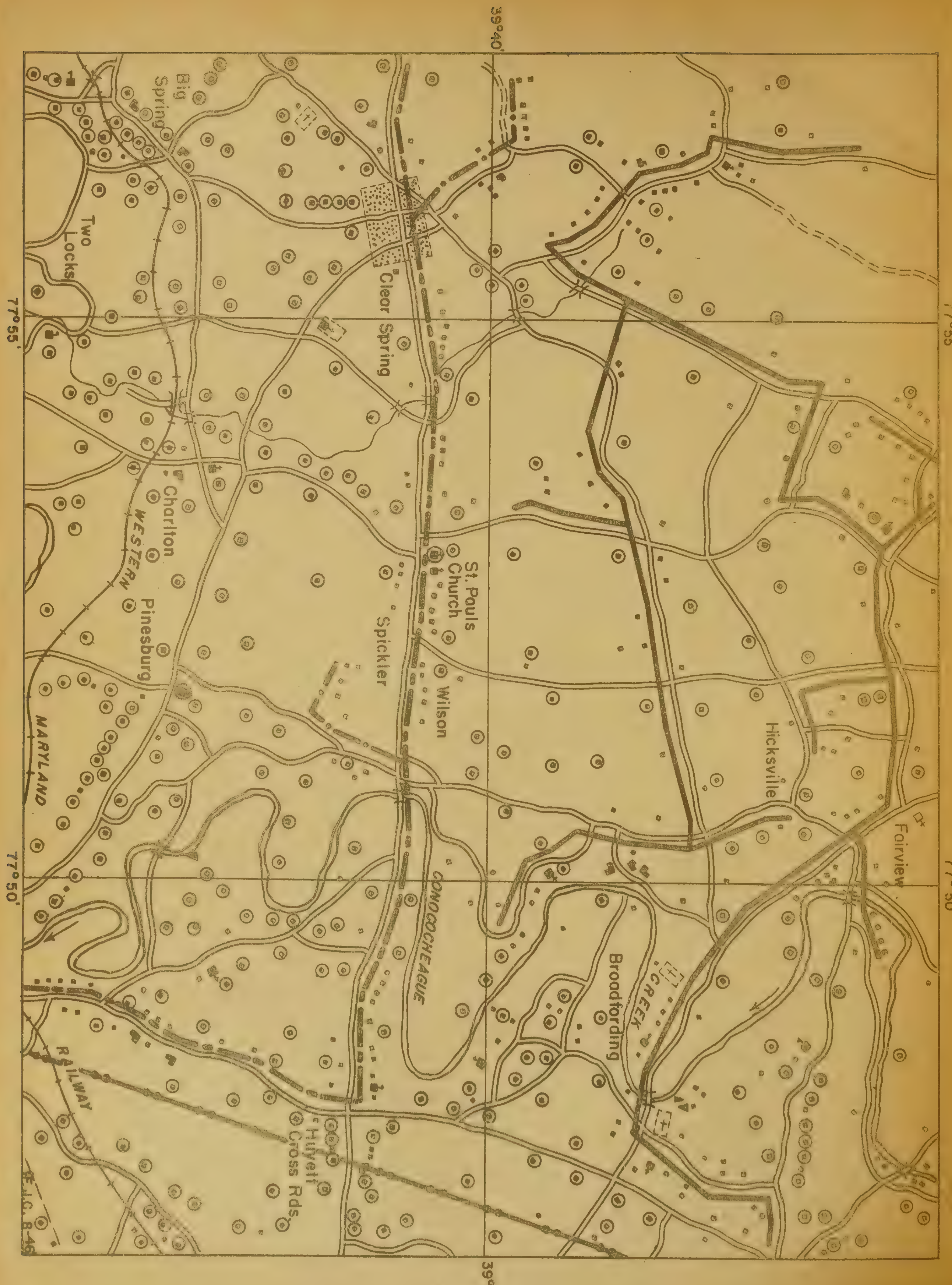
Underpass

State Line

County Line

Township Line

Section Line



39°40'
77°55'
77°50'
Big Spring
Two Locks
Clear Spring
Charlton
WESTERN
MARYLAND
RAILWAY
Pinesburg
Spickler
St. Pauls Church
Wilson
CONOCOCHEAGUE
CREEK
Broadfording
Hicksville
Fairview
Huyett Cross Rds.
E.J.C. 8-46

APPENDIX B

(Basic Concepts of Loads)

A. LOADS AND THEIR CHARACTERISTICS

A study of loads and their characteristics involves not only the different types of apparatus used and the grouping of such apparatus to form the load of an individual consumer, but also the grouping of such loads into still larger diversified groups. For example, the electric range should be studied as a piece of apparatus which is quite commonly used. Its characteristics as an individual load should be understood. Further, its effect on the total load of a consumer using it as a part of his electrical equipment must be considered. Then, farm load as a class must be studied, that is, the load imposed on a system by an area distinctly rural in character and including consumers using electric ranges, refrigerators, etc. Finally, attention must be given to composite loads drawn by larger areas, consisting of certain proportions of industrial power load, irrigation load, non-farm, and recreational load as well as farm load, and perhaps of other characteristically different types. Such a load would be represented by the total load on a substation carrying both farm and power loads, irrigation, commercial, etc.

Before proceeding with the study of particular types of loads, it is essential that an understanding be had of what are the important characteristics of a load and how, in general, they affect the design of the system. A few simple definitions are in order at this point.

Demand: The size of any load, or its demand, is the maximum load, expressed in kilowatts (KW) at a certain power factor, or in kilovolt-amperes (KVA), which is drawn from the source of supply at the receiving or delivery point. The determination of the demand of any load or group of loads is of the highest importance since it is the demand which governs the size of conductors, transformers, etc.

Demand Factor: The distinction between demand and connected load on any service should be noted. Connected load is the total of the rated capacities of all electric appliances, lamps, motors, etc., which are connected to the wiring of that service. The actual demand in nearly all cases is considerably less than the connected load due to the fact that different pieces of apparatus are used at different times. The ratio of maximum power demand to the total connected load is called the demand factor. For example, ten 5-hp. motors on one service may have an actual demand of only 25 hp. instead of 50 hp. In this case, the demand factor equals 25/50 or 50 percent. Demand factor is usually applied to the demand of an individual consumer and should not be confused with diversity factor.

Diversity Factor: The diversity factor is the ratio of the sum of maximum power demands of the component parts of any load to the maximum demand of the load as a whole measured at the point of supply. For example, a transformer may serve five consumers, each with a maximum demand of 4 KVA. Due to the

Diversity Factor (Continued)
fact that the maximum demands of all five do not come at the same time, the actual demand on the transformer may be only 10 KVA instead of 20 KVA. In this case the diversity factor equals 20/10, or 2. (It should be noted that demand factor is defined in such a way that it is always less than 1; diversity factor in such a way that it is always greater than 1, that is, the form of one is the reciprocal of the other).

Such diversity is found between consumers, between transformers, between feeders, between substations, etc. It can be used to marked advantage in reducing the required capacity of such parts of the system from that which would be necessary if design were based on connected load or on the sum of component demands only.

Load Factor: Load factor is the ratio of the average power for a certain stipulated period of time, such as a day, a month, or a year, to the maximum power or demand for a short interval of time (say 15-minute integrated demand) during the same period. In referring to the load factor in any particular case, both the interval of time for the maximum demand and also the period of time for which the average power is taken should be specified. Load factor is an index of the efficiency with which the system under consideration is utilized, 100 percent load factor or 24-hour per day operation at peak load being the maximum possible.

B. APPLICATION OF LOAD CHARACTERISTICS TO FARM USAGE

Farm Lighting: Lamps form a part of nearly all consumers' loads since artificial illumination, for a part of the day at least, is necessary. Lamp load of itself shows no diversity between individual units (lamps) when in operation since the load of each lamp is essentially constant while it is in use. There is considerable diversity in use, however, especially in residence lighting where only a comparatively small proportion of the total number of lamps connected is ordinarily used at any one time.

The load factor of lamp load may be almost any amount from a very small value for lamps which are used occasionally up to 100 percent where they are used continuously. For the ordinary residence, the lamp load factor is rather low (probably not over 10 to 15 percent on a yearly basis) since illumination is required for only a comparatively small portion of the day. In stores and offices it will run somewhat higher as a rule due to the greater daytime use. Street lighting lamp load has usually a fairly high load factor especially where all night lighting is practiced (of the order of 50 percent).

Figure 1 on the following page shows a typical residence-lighting load curve for 1,000 consumers:

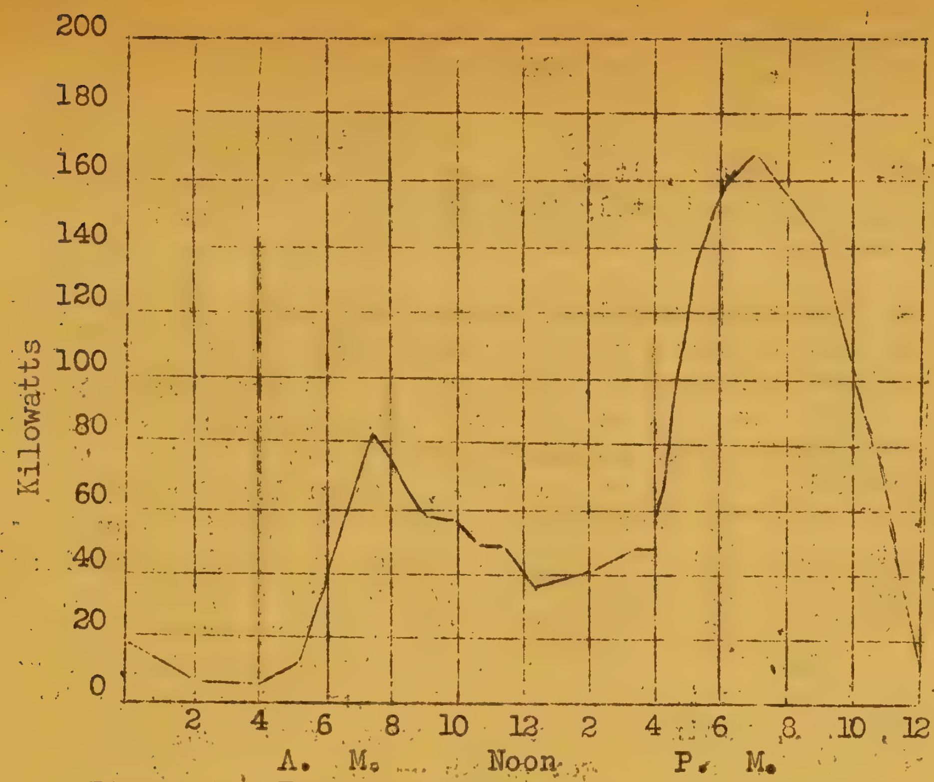


Figure 1. Typical daily load - 1,000 Consumers, lighting.

It is noted from Figure 1 that the maximum demand created by lighting and minor other uses for 1000 residential consumers is approximately 165 KW. Since the curve in Figure 1 takes into consideration the diversity between consumers, the average demand contributed by each consumer to the actual peak lighting demand is .165 KW.

Due to earlier rising time and other characteristic farm practices, it is felt that farm residential lighting demands as well as the load factor of this type of load may slightly exceed the above figures on the average farm. For this reason, the average demand per consumer at peak load for farm residence lighting has been estimated at 0.2 KW, or 200 KW per 1000 farm consumers. Applying a 17 percent lighting load factor (annual) to this demand, we have:

> 8760 (hours in 1 year) x 200 x 17% = 297,840 KWH or an average consumption of approximately 297 KWH per farm consumer per year for lighting and minor other uses.

Refrigerators: Refrigeration equipment is usually operated automatically (thermostatically) and is as likely to be operated at the time of peak load as at any other time, thus adding directly to the peak. Since they are operated intermittently on a fairly constant mechanical load, their load factor is comparatively high and the diversity comparatively low.

From load curves similar to Figure 1, it has been found that 1000 refrigerators operating on a system may contribute approximately 68 KW toward the overall system peak even though the connected load of 1000 refrigerators would be much greater. On the basis of a 70 percent refrigeration load factor (annual) as applied to the peak demand of 68 KW, the annual KWH consumption

of 1000 refrigerators would be:

8760 X 68 X .70, or 416,976 KWH.

This is an average of 417 KWH per year per refrigerator, or 35 KWH per month per refrigerator. Similarly, it is seen that each refrigerator contributes an average demand of approximately 0.07 KW to the overall peak demand of the system.

<u>Electric Ranges</u>: The connected load of ranges varies with the number of heating elements contained and usually ranges from about 4 KW for smaller ones to 7 or 8 KW for larger ones. The average is probably between 6 and 7 KW. Since the range is made up of several smaller units or elements, usually ranging from 500 watts to 2000 watts in size, it is rather rare that the whole connected load is on at one time, especially for any appreciable length of time. The actual peak demand for the range will equal its total rating or connected load but this may be experienced only occasionally, the ordinary daily demand being perhaps only 1/2 to 2/3 as great and even that for short periods only. The diversity between several ranges in a group, under ordinary conditions of household use is therefore high. Tests made in various localities have indicated that the diversity factor (based on actual peak load, i.e., rating of range) between three ranges is about 3, and increases to 5 to 7 for a larger group -- that is, 20 ranges or more. The average demand of a large group of ranges, 200 to 1000 of various sizes has been given as 728 watts. It is safe to say that the average for even much smaller groups (over 20 ranges) will not be more than 1 KW each. The range peak <u>for a few ranges</u> may be less than the lighting peak and hence will add only a comparatively much smaller amount to that peak. Where the percent saturation of ranges is large in comparison to the number of lighting consumers served, the range load may well predominate, since few groups of farm consumers have an average lighting demand of anything like 1 KW per farm.

Load factor for a single range is very low, but for a group of ranges is much better, being somewhat of the same order as load factor for lighting load. An annual load factor of 4 percent for a single range based on its peak demand and 23.2 percent for a large group (200 or over) based on the group demand has been found by test. Applying a load factor of 23.2 percent to the peak demand of 670 KW (demand of 1000 ranges as found from tests) we can calculate the KWH used by 1000 ranges over the period of one year, as follows:

8760 x 670 x 23.2% = 1,361,654 KWH

From this it is seen that the average consumption per year per range would be 1362 KWH or 113 KWH per month per range. These calculations compare favorably with accepted estimates of 100-120 KWH per month per range, or 1200 to 1440 KWH per year.

On average REA projects where the percent saturation of ranges connected will be large compared to total number of consumers, the average demand per range contributing to the overall peak demand of the system may be taken as approximately 0.75 KW; on smaller projects where the estimated number of ranges connected will be less than 200, it may be well to use an estimated average demand per range of 1.0 KW as contributing to the overall peak system demand.

Water Heaters: The water heater is likely to be turned on at the time of the peak lighting load, especially if it is automatically operated, and hence may add to the peak demand of the consumer and of the distribution system.

Operations Memorandum 28-2 dated September 30, 1945, makes the following comment on electric water heating with respect to REA systems:

> "A careful consideration of this problem convinces us that at present it will not be necessary to require the installation of time switches to control these heaters on an off-peak basis. However, as peak-load conditions develop on the individual systems, this will become a matter of concern, and at that time it will become necessary to install time switches.
>
> "Water heaters for use in controlled 'off-peak' service shall be of the double element type, 230-240 volt. Neither the upper nor lower element shall exceed 2500-watt capacity. The upper element shall be located near the top of the tank so that it will heat the top fourth of the water and so connected that it can operate at any time except when the lower element is in operation. This is accomplished by using a three-point thermostat to control the upper element and by not opening this circuit with the time switch. Lower element shall be equipped with a standard thermostat, shall operate only during 'off-peak' periods and can be controlled by a time switch. Time switches to control the lower element shall be operated by a 230-240 volt synchronous motor with an auxiliary electrically wound clock mechanism to provide a fifteen-hour carryover period in case of service interruption."

From the above we can assume that time switches will be used in the future on systems where water heaters develop into more general use and where the percent saturation of consumers having water heaters will be substantial as compared with the total number of consumers served.

Since for purposes of estimating the demand of water heating load, we are primarily concerned with that portion of the load that will contribute to the overall system peak, we may automatically eliminate the 50 percent of the connected load which will be controlled by time switches. The actual peak demand of a single water heater will therefore equal 1/2 its total rating or connected load. The diversity between several water heaters in a group under ordinary conditions of household and farm use would be comparatively low. It is assumed that since the uncontrolled element of a water heater would be automatically (thermostatically) operated during the system peak, the diversity factor for a large group of water heaters - that is, 20 or more - would be comparable to that of a similar number of refrigerators, or something like 3.4 to 4. The average demand of a large group of water heaters, 200 to 1000 of the type recommended for consumers on REA systems, would be approximately 735 watts per water heater using the assumed diversity factor of 3.4.

It should be emphasized that the above discussion of average demand as applied to a group of water heaters refers to that portion of the water heating load which may directly contribute to the peak demand of the system, even when time clocks are used with the particular type of water heater discussed.

Small Heating Appliances: Small heating appliances are a large contributing factor to the comfort of the modern household and form a part of nearly all farm and residence loads. They include flat irons, toasters, percolators, heating pads, waffle irons, heaters, curling irons, and an infinite number of other similar devices. As a rule, they are probably more effective in increasing the consumption of current, that is, improving the load factor, than in adding to the load demand except in the case of the larger units. Most of them are used more or less intermittently and at times of the day other than when the lighting peak is on, hence their load factor (of each unit individually) is usually extremely low and the diversity between various units very high. On any one service, the actual peak demand may be due to one or more of such appliances - a toaster or flatiron drawing 750 watts, if added to a certain amount of lighting, may well exceed the peak due to lighting along. The high diversity and time of use, however, will cause the effect on the total demand of a group of such loads to be comparatively small.

Small Motors: Fractional horsepower motors are the motive power for vacuum cleaners, washing machines, ventilating fans, electric refrigerators, electrically-operated oil burners (furnaces), and similar equipment.

A very high diversity factor and low-load factor is obtained with such appliances as vacuum cleaners, washing machines, etc., whose use is only occasional and for comparatively short periods. Rarely do they add any appreciable amount to the peak load, their effect being chiefly an increase in consumption and hence in load factor. With refrigerators and oil burners, however, the case is somewhat different as was seen in the previous discussion on refrigerators. Oil burners compare favorably with refrigerators, except for their seasonal use, and will not be discussed here.

Commercial Load (Stores, Small Manufacturing Shops, Theaters, Markets, Etc.): Commercial load is characteristically a combined light and power load with the lighting usually predominating but not always. The proportion in which they combine depends entirely on conditions - for example, the ordinary small store will have a few motors such as coffee or meat grinders, ventilating fans, refrigerating machines, etc., but these run intermittently and may take a very small load compared with the lighting which may include a fairly large demand for window lighting, electric signs, display lighting, etc. The diversity between individual demands for power load only is likely to be high since the power load is usually diversified as to use. For the lighting load, however, a low diversity will usually exist since with such lighting, nearly all the connected load is likely to be used at the same time. There is not likely to be much diversity between power and lighting peak for such loads.

Power Load (Rural Industries): There is no definite dividing line between what may be called power loads and the commercial loads discussed above. Power loads are usually thought of as being predominately power with only a comparatively small amount of lighting.

Power loads are governed by differences in type of manufacture, method of operation, plant design, efficiency of management, and numerous other factors so that there is quite a wide variation in such elements as power factor, load

Power Load (Rural Industries): (Continued)
factor, diversity, etc., not only between different industries but also between different indivuduals in the same industry. Such figures as can be given in this regard must be considered as only very general and not applicable with any degree of accuracy to any particular case without further investigation. With this reservation, some characteristic demand factors for various industries are listed below:

Type of Manufacturing	Demand Factor
Boat	0.51
Cement and Asbestos products	0.63
Chemical	0.50
Cleaners and dyers	0.68
Clothing	0.45
Creamery	0.77
Excelsior	0.90
Grain elevator	0.69
Ice	0.92
Knitting mills	0.86
Laundry	0.82
Lime products	0.65
Lumber	0.64
Meat packing	0.79
Paper	0.75
Paper products	0.47
Pottery	0.60
Tobacco	0.61
Woodworking	0.55

If we wish to get more accurate demand factors, the following must be considered:

1. Total connected load - as the total connected load increased the demand factor decreases.
2. Size of individual motors - the larger the motors compared with total load, the higher the demand factor.
3. Grouping of motors, i.e., whether consumer has all large or all small motors, or a number of each.
4. Ratio of size of large motors to small motors.

Irrigation Loads: Irrigation loads may easily predominate over all other composite loads of a system in areas where the practice of irrigation is extensive. Examples of such cases may be found in arid areas of Colorado and New Mexico. Though seasonal in character, ranging from 4 to 8 months or more, depending on the growing season, the irrigation pump load is as likely to occur at the time of peak load as at any other time, thus adding directly to the peak. Since the pumps are operated seasonally, and even then intermittently to a great extent, their annual load factor is usually comparatively low.

On the following page is a chart which has been prepared for use in calculating KWH consumption for irrigation loads under various conditions. In using the chart the following information would first have to be obtained in the area under study:

(1) Crops grown.
(2) Acreage devoted to each crop (average).
(3) Feet of water applied to each crop per season.
(f) Total pumping head in feet. If pumping against a pressure, such as distributing water through a sprinkling system, the pounds per square inch (pressure) should be multiplied by 2.31 to obtain feet of head, and this result added to the lift in feet to obtain the total head in feet.
(5) Capacity of pump or well in gallons per minute.

Example: The above information is obtained and water requirements determined in the following manner for an average farm:

Crops Grown	Acres		Water Applied Per Season (Feet)		Acre Feet Applied
Alfalfa	5	X	3	=	15
Sugar Beets	15	X	1-1/2	=	22-1/2
Corn	10	X	1-1/2	=	15
Barley	5	X	1-1/2	=	7-1/2
Potatoes	5	X	1-1/2	=	7-1/2
	Total acre-feet of water applied				67-1/2

The irrigator (or county agent) states that a well, or wells in the general area, will produce about 950 gallons per minute with a 55-foot lift. On looking at the chart, we find that the chart is not made up for 55 feet; however, if the output of a pump is increased, the depth to water will usually increase, and when the capacity is decreased the lift will be less. From the chart we find that at a 50-foot head 910 gallons per minute can be pumped with a 15 h.p. motor with a 13.2 KW demand, and at 60-foot head 1010 gallons per minute can be pumped with a 20 h.p. motor, creating a 17.6 KW demand. The smaller motor will create less KW demand on REA lines and by pumping longer hours the same quantity of water may be pumped as with the larger motor. Therefore, we will select the 15 h.p. installation which uses 13.2 KWH per hour of operation. From this we can calculate the KWH consumption required to pump the 67-1/2 acre-feet of water desired for irrigation as follows:

Hours required to pump 1 acre-foot: $\dfrac{\text{325,850 Gal. per acre foot}}{\text{Gal. per min. X 60 min.}} = \dfrac{5430}{\text{G.P.M.}}$

Since the installation chosen will pump 910 gallons per minute,

Hours required to pump 1 acre-foot: $\dfrac{5430}{910} = 5.97$

Time required to pump 67-1/2 acre-feet: 67.5 x 5.97 = 403 hours

Electrical consumption from chart was 13.2 KWH per hour of operation. Therefore, KWH required to pump 67-1/2 acre-feet: 403 x 13.2 = 5319.

CAPACITY PUMPED - GALLONS PER MINUTE
BASED ON 65 PER CENT OVERALL (WIRE TO WATER) EFFICIENCY

Horse Power Motors	Feet of Head 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	KWH per hour of operation & KW demand of motor based on 85% motor efficiency
5	1520	760	510	380	300	250	220	190	170	150	140	130	120	110	100	95	90	85	80	4.4
7½	2280	1140	760	570	460	380	330	280	250	230	210	190	180	160	150	140	135	125	120	6.6
10	3040	1520	1000	760	610	510	430	380	340	300	280	250	230	220	200	190	180	170	160	8.8
15	4560	2280	1520	1140	910	760	650	570	510	460	410	380	350	330	300	280	270	250	240	13.2
20	6080	3040	2010	1520	1220	1010	870	760	680	610	550	510	470	430	400	380	360	340	320	17.6
25	7610	3800	2540	1900	1520	1270	1090	950	850	760	690	630	530	540	510	480	450	420	400	22.0
30	9130	4560	3020	2280	1830	1520	1310	1140	1020	910	830	760	700	650	610	570	540	510	480	26.4
40	12200	6100	4060	3050	2440	2020	1740	1520	1360	1220	1110	1020	940	870	810	760	720	680	640	35.2
50	15200	7600	5070	3800	3040	2530	2170	1900	1690	1520	1380	1270	1170	1080	1010	950	890	840	800	43.9

This chart may be used for approximation and should not be used for actual installation.

Head equals feet of lift to ground surface plus additional feet to point where water is discharged.

1 Acre Foot - 325,850 Gallons
450 gallons per minute - 1 acre inch per hour - approx.
1 pound per square inch - 2.31 foot head of water.

From the above example it is seen that the installation chosen would create a 13.2 KW demand and that 5319 KWH would be consumed per season in supplying the water required for irrigation.

The chart may be equally useful in calculating KWH consumption where water is pumped from rivers and streams into gravity ditches, or into sprinkler systems.

Farm Equipment: In addition to the typical home equipment items and appliances, some of which have already been discussed, the modern farm will be equipped with various items of farm equipment, including brooders, cream separators, dairy water heaters, milk coolers, ensilage cutters, milking machines, tool grinders, water pumps, and cut-off saws (wood fuel) to mention a few. A great deal of this equipment will be operated during daylight hours or at times other than that at which the system peak occurs. Rarely will they add any appreciable amount to the peak load of a consumer or system, their effect being chiefly an increase in consumption and hence in load factor. A very high diversity factor and low load factor (individual units) is obtained with such equipment.

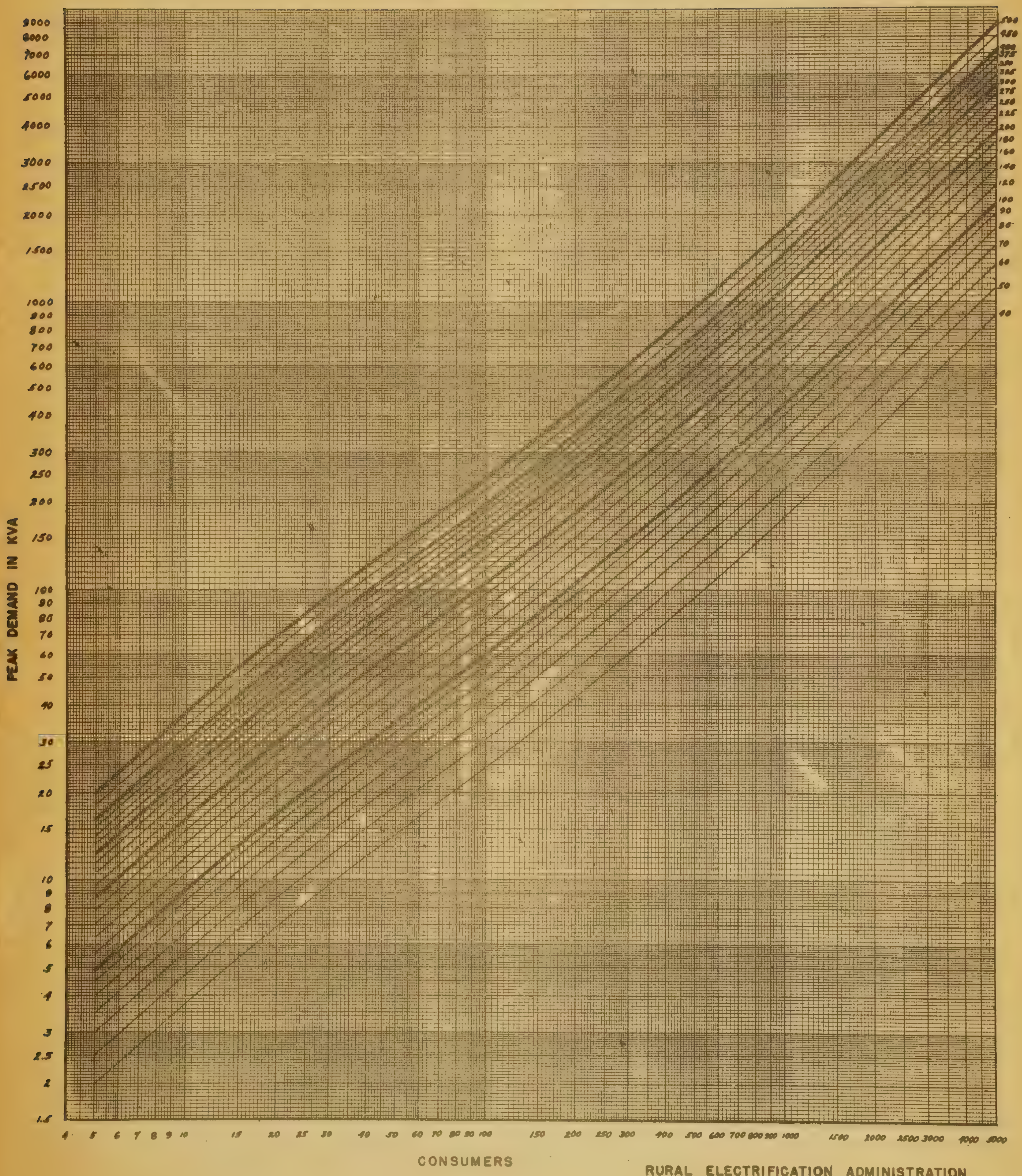
Admittedly, such items of equipment as barn ventilators, chick and pig brooders, dairy water heaters, milk coolers, poultry house lighting, barn lighting, and water pumps would create some demand responsibility on a system. It would not seem desirable nor practical to treat each of the above items separately and attempt to determine the demand responsibility of each appliance. Rather, it is felt that such items may be treated as a group and an estimate made of the demand responsibility for this type of load based upon the conditions found in the field. For instance, on projects where the estimates of present saturation in the use of farm equipment are found to be substantial (50% or more) the field man may elect to include in his estimates of average demand per farm consumer an arbitrary figure of 0.2 KW per consumer to cover the demand responsibility attributed to the use of farm equipment generally; on other projects with lower estimates of percent saturation and where less favorable conditions are found, he may elect a smaller figure of say 0.15 KW per farm consumer.

APPENDIX C

(Maximum Demand Curves)

MAXIMUM DEMAND

At Substation



RURAL ELECTRIFICATION ADMINISTRATION

May 22, 1946

APPENDIX D

(KWH Consumption Estimates Per Unit Appliance)

ESTIMATED AVERAGE YEARLY CONSUMPTION
PER UNIT APPLIANCE
(FARM USAGE)

Appliance (Domestic)	Average Annual Consumption KWH
Lighting	
(1) Northern States	300
(2) Southern States	240
Clock	18
Clothes Drier	250
Dishwasher	30
Fan, Ventilator	25
Fan, Furnace	240
Food Mixer	25
Freezer Cabinet (Walk-in)	1500
Freezer Cabinet (Reach-in)	900
Heater, Space (Radiant)	70
Hot Plate	70
Iron	60
Ironing Machine	120
Oil Burner	300
Percolator	60
Radio	100
Range	1200
Refrigerator	360
Roaster	480
Room-Cooler	800-1200
Sewing Machine	10
Stoker, Coal	240
Toaster	35
Vacuum Cleaner	20
Waffle Iron	25
Washing Machine	35
Water Heater	2880

ESTIMATED AVERAGE YEARLY CONSUMPTION
PER UNIT APPLIANCE
(FARM USAGE)

Appliance (Farm Equipment)	Estimated Annual KWH Consumption
Lighting	
(a) General Barn	24
(b) Poultry Laying House (100 birds)	35
(c) Poultry Brooding House	5
(d) Dairy Barn	
(1) North	80
(2) Mid-Continental U. S.	60
(3) South	35
(e) Dairy Milk House	35
(f) Beef Cattle Barn	12
Air Compressor	35
Barn Cleaner (twice daily)	120
Barn Ventilator Fan (dairy)	200
Blower - Grain (1,500 bu.)	35
Blower - Roughage	100
Brooder - Pig (per litter)	25
Brooder - Lamb (per 100 lambs)	100
Brooder - Chick (Hover)(3/4 kwh per chick) (500 chick brooder)	360
Brooder - Chick (Battery 1200 chick size)	1200
Churn	3
Cordwood Saw (for fuel wood) (15 cords)	30
Corn Sheller (small motor)(500 bu.)	25
Cream Separator (72,000 lbs. milk)	35
Drill Press	12
Egg Cooler (fan type)	25
Electric Hotbed (Cable Type)(2-sash bed)	240
Ensilage Cutter (50 tons)	50
Feed Grinder	120-600
Feed Chopper	12
Fence (electric)	50
Feed Mixer	12
Flour and Cereal Mill	6
Fruit Cleaner	60
Fruit Grader	60
Garden Watering (1/4 Acre)(6" water)	75
Grain Dryer (per 1000 bushels)	1500
Grain Elevator (per 1500 bu.)	5
Hay Drier (per 50 tons)	2500
Irrigation	
(1) Shallow Well (15' lift)(per 10 acre-feet)	360
(2) Deep Well (75' lift)(per 10 acre-feet)	1800
(3) Surface Water (15' lift)(per 10 acre-feet)	360
Milk Cooler (Immersion)(1 kwh per can per month)	.900
Milking Machine (15 cows)(milked 10 months)	400
Potato Grader (small motor)	60

ESTIMATED AVERAGE YEARLY CONSUMPTION
PER UNIT APPLIANCE
(FARM USAGE)

Appliance (Farm Equipment)	Estimated Annual KWH Consumption
Roughage Elevator	5
Seed Cleaner	3
Soil Sterilizer (for 2-sash bed)	30
Stock Tank Heater	150
Sugar Cane Press	300
Sweet Potato Curing (Southern States)	1800
Tobacco Curing (Stoker)	18
Tool Grinder	25
Vegetable Grader	60
Water Heater (Dairy)	1500
Water Pump (Deep well)	240
Water Pump	180
Welder	100
Wood Saw (Bench)	12

APPENDIX E

(Preparation of Allocation Packets
and
Systen Load Studies)

MEMORANDUM

November 22, 1946

To: Division Chiefs

From: Claude R. Wickard, Administrator

Subject: Preparation of Allocation Packets and System Load Studies

* * * * * *

II. Preparation of System Load Studies

1. Definition of a system load study: A study of a specified area for the purpose of arriving at estimates of KWH consumption, types of loads and their distribution in the area, power requirements and approximate load centers for power deliveries.

2. Purposes to be served by a system load study are the following:

   (a) To permit the making of engineering and economic studies relating to the construction or extension of transmission networks of public power agencies and generating and transmission systems to assure adequate low-cost wholesale power.

   (b) To permit adequate engineering studies of the modification of present borrowers' facilities and the design of future construction.

   (c) To provide a foundation for a sound, long-range rate structure.

   (d) To serve as a guide in providing for an effective power use program.

3. System Load Studies shall be made by the A & L Division.

   (a) The Administrator shall be notified of each system load study to be undertaken and a copy of the notification shall go to the Engineering Division.

   (b) The Office of the Chief of A & L Division shall establish uniform policies and plans for system load studies and shall maintain appropriate controls over the assignment and progress of such studies.

4. KWH Consumption for farm consumers shall, for purposes of a system load study, be estimated by the field representative on the basis of information obtained through use of the field appraisal form, parts I and II. The basis for the

farm consumption estimate shall be clearly stated. Because of the difficulty of interperting the results obtained from a mail questionnaire it is recommended that where this method is used to obtain information from rural consumers, in each case the returns shall be spotted on the system map as an aid in evaluating the sample obtained. In any event, the estimate of farm KWH consumption shall be based on the complete field appraisal with the results obtained from a mail questionnaire to be used as only one element in arriving at such a determination. In case a system load study is to be made in an area where no REA system now exists and where the prospects are good that an REA project may be developed, a field appraisal shall be requested of the Economic Staff by the Chief of A & L. This will avoid the necessity for a detailed field appraisal of the area when a loan application is made at a later date.

(a) The A & L regional field representative shall supervise the making of the field survey and shall, except as noted above, obtain the information covered in Parts I and II of the field appraisal form. The survey shall include the making of an unelectrified farm survey if one has not been made.

(b) A detailed system load study manual of instructions shall be prepared for use of the field representatives. The responsibility for the preparation and instruction of the use of such a manual shall be assigned to the System Load Study Specialist of A & L and the Economic Staff.

5. The Office of the Chief of A & L shall assign field representatives to make system load studies. The field representative shall follow in detail the manual of instructions for making such appraisals.

6. After the field representative has completed the system load study he shall transmit it to the appropriate regional head. If the regional head approves the system load report it shall be submitted to the Economic Staff for its written comments. When the report is submitted to the Administrator for his approval by the Chief of A & L the comment's of the regional head and of the Economic Staff shall be attached.

7. If the material, after its approval by the Administrator, is to be transmitted to another agency the necessary correspondence shall be prepared by A & L for the Administrator's signature. Preliminary results shall not be released to any agency, including the cooperative involved, except with the approval of the Administrator.

APPENDIX F

PARTIAL LIST

OF

Types of Rural Industries Receiving REA Service
(For all of United States)

PARTIAL LIST

of

Types of Rural Industries Receiving REA Service
(For all of United States)

AGRICULTURE

1. Locker Plant
2. Rendering Plant
3. Flour Mills
4. Soy Bean Processing
5. Cotton Gins
6. Potato Drying
7. Peach Packing and Grading
8. Elevators
9. War Hemp Industry
10. Ice Cream Plant
11. Ice Plant
12. Hay and Grain Drying
13. Creamery Plants
14. Chicken Hatchery
15. Meat Packing Plant
16. Cabbage Processing Plant
17. Peanut Processing
18. Citrus Packing and Processing
19. Sugar Refinery
20. Cane Mill
21. Powdered Egg Processing and Packing
22. Alfalfa and Clover Seed Processing
23. Milk Processing
24. Sweet Potato Curing Plants
25. Plastic Plant (Soy Bean)
26. Tankage Processing
27. Cotton Seed Oil Mill
28. Cheese Factory
29. Bean Cleaners
30. Seed Drying Plant
31. Fertilizer Plant
32. Agriculture Lime Crushing
33. Peat Moss Processing
34. Fish Hatchery

WOODWORKING

1. Planing Mill
2. Box Factory
3. Furniture Factory
4. Pulp Mill (Rough)
5. Veneer Plant

WOODWORKING (Continued)

6. Plywood Mill
7. Wooden Kitchen Ware Manufacturing
8. Boat Works
9. Wooden Hoisting Block Manufacturing
10. Kraft Paper Mill
11. Excelsior Mill
12. Saw Mill

GOVERNMENT PUBLIC UTILITIES

1. Weather Stations
2. Gas Company Plant
3. Compressor Station
4. Filtration Plant
5. U. S. National Guard
6. Recreational Park
7. U. S. Forest Service
8. Broadcasting Station
9. State Boys' Industrial School

MINERAL PRODUCTS

1. Coal Dock
2. Oil Refinery
3. Oil Well Drilling
4. Secondary Crude Oil Recovery Plants
5. Rock Quarry
6. Asphalt Refining Plant
7. Gasoline Storage Plant
8. Rock Wool Plant
9. Carbon Black Plant
10. Fire Brick Plant
11. Glass Sand Processing
12. Smelting
13. Helium Plant
14. Mines (Approximately 27 different types of mines are being served.)

PARTIAL LIST
of
Types of Rural Industries Receiving REA Service
(For all United States)
(Continued —)

MISCELLANEOUS, INDUSTRIAL AND COMMERCIAL LOADS

1. Welding Shop
2. Standby Service - Municipal
3. Electric Furnace
4. Signal and Fireworks
5. Tool and Die Casting Company
6. Carburetor and Motor Parts Plant
7. Fire Pump (RR)
8. Tapestry Mill
9. Hosiery Mill
10. Farm Machinery Repair Shop
11. Peat Plant
12. Bottling Plant
13. Cement Block Plant
14. Metal Stamping
15. Chemical Factory
16. Porcelain Plant
17. Railroad Shops
18. Distillery
19. Marble Polishing and Finishing